EXPERIMENTAL INVESTIGATION OF MATERIALS

FOR

PARACHUTES FOR ILLUMINATING SHELLS

by

J. W. McCarty

Project No. 237--208

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Goergia
1953

CONTENTS

Proj. 237

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA

May 1, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 1
Contractors Purchase Order G No. 942
Sub-Contract to Prime Contract DA-33-008-ORD-568

Gentlemen:

Progress to date (April 1, 1953, through April 25, 1953) has consisted mainly of the analysis of the problem, determination of some of the project requirements, assembling of personnel, and literature survey.

Under contract No. AF 33(038)-15624, E.O. No. 602-193 SR-7S, the Engineering Experiment Station of the Georgia Institute of Technology has been working for some time on a project entitled "Air Permeability of Parachute Cloths." For this project, the Materials Laboratory of Wright Air Development Center has accumulated quite a number of different nylon parachute materials, and the Georgia Institute of Technology has woven several nylon cloths, orlon cloths, and dacron cloths. Study is being made of the reports and results of this project to determine which of these data can be utilized in the subject project, and arrangements have been made to secure a small quantity of each of these fabrics on which further tests can be made.

Under AF Contract No. 33(038)-10401 RDO No. 612-12, the Pioneer Parachute Company recently made a study entitled "Investigation of Impact Load Absorption Through Suspension Line Elongation." The report of this work (WADC Technical Report 52-57) is being studied carefully to determine which of the data included can be utilized in the subject project.

Under AF Contract No. 33(038)-22932 E.O. No. R602-193ST-7S, the Fabric Research Laboratories, Inc., has completed a final report on a project entitled "Research on The Effect of Temperature and Humidity on the Properties of Textile Materials." This report is being studied to determine if any of the findings of these studies will be applicable to the subject project.

A copy of the USAF Parachute Handbook, prepared by the Parachute Branch, Equipment Laboratory, Engineering Division, Wright Air Development Center, has been secured and the details of parachute construction and performance data contained therein are being studied by project personnel.

During this period the writer, accompanied by Dr. Frederick Bellinger, Head, Chemical Science Division of the Engineering Experiment Station, and Professor H. W. S. LaVier, Research Associate Professor of the Engineering Experiment Station, visited TEMCO in Nashville and conferred with the various staff members concerned with the problems of the subject contract. This conference helped to clarify the work to be done by the Engineering Experiment Station on the subject project. Also discussed at this conference was the urgency of the development of an interim improvement over the present flare parachute. Professor LaVier and the writer have been working on the details of such an interim improvement during this period and expect to have some specifications and suggestions ready in the near future.

At the above-mentioned conference, it was suggested that the Wright Air Development Center might have done some research along some of the lines of the subject project. Professor LaVier and myself plan to visit WADC in Dayton, Ohio, in the near future to discuss with their Materials Laboratory some of the phases of this work.

All of the standard test equipment to be needed for experimental purposes is at hand except for a high-capacity tester to be used for strength testing of the shroud lines. A Scott Horizontal Tester, having a capacity of two thousand pounds, has been ordered and is scheduled to be delivered about May fifteenth.

Preliminary study has been made regarding the method by which the fabrics may be tested at low and high temperatures. Plans for such testing are being formulated and it is expected that they will be completed in the near future.

Personnel assigned to the project at present include:

Mr. J. W. McCarty	Project Director	part-time
Mr. H. W. S. LaVier	Research Associate Professor	part-time
Mrs. Jerry Dunnam	Technical Assistant	full-time
Mrs. Ival Fern Stiltner	Technical Assistant	full-time

Respectfully submitted,

J. W. McCarty
Project Director

APPROVED:

Hershel H. Cudd, Acting Director
Engineering Experiment Station

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA

May 28, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 2
Contractors Purchase Order G. No. 942
Subcontract to Prime Contract DA-33-008-ORD-568

Gentlemen:

Work on the project during the current period (April 27, 1953, to May 23, 1953) has consisted mainly of more detailed study of the reports mentioned in Progress Report No. 1 and work on an interim improvement over the present flare parachute.

During the period, Professor LaVier and the writer visited Wright Air Development Center in Dayton, Ohio, and discussed with Mr. W. A. Corry, Chief, Textile Branch, some of the phases of the subject project. We had a most cordial reception and were promised the complete cooperation of WADC Textile Branch in this connection. We already have their permission to use any data contained in the previously mentioned reports and also have been allotted small samples of the 169 parachute cloths which the Air Force assembled and wove for testing in Contract No. AF 33(038)-15624 at the Georgia Institute of Technology. WADC also has a final report on Contract No. W 33-038-ac-15826. This is a report of a project performed by the Massachusetts Institute of Technology entitled

"Impact Investigation of Textile Materials - Studies on Shroud Lines." It is hoped that a copy of this report, as promised by Mr. Corry, will be received in the near future and that a study of the information contained therein will prove of benefit to the personnel of the subject project.

We were pleased to have Mr. James Carter, Project Engineer, TEMCO, Inc., Nashville, Tennessee, visit the Georgia Institute of Technology during the period. Professor LaVier and the writer discussed the progress and plans for the project at length with Mr. Carter and showed him some of the facilities of the Engineering Experiment Station. It is felt that several points regarding the work to be done by us were clarified by this conference.

The details of our suggestions for an interim improvement over the present flare parachute have been completed and are shown in Interim Report No. 1, which should reach you by June 5th. Briefly, this report recommends the use of a 4.7-foot-diameter gathered parasheet having ten round-braid fiberglass-with-nylon-core shroud lines.

It is suggested that about ten completed parachutes be constructed for test firing, five without any reinforcing tape and five with reinforcing tape joining the parasheet suspension line ends across the parachute surface or crown.

If convenient, Professor LaVier and the writer would like to be present at the test firing of these interim parachutes in order to observe their performance and thus be in a better position to offer other suggestions should the parachutes made from these specifications not prove satisfactory.

The 2,000-pound capacity Scott Horizontal Tester which was ordered to complete the basic equipment needed on the subject project has been received and is now being installed and adjusted.

There has been no change in personnel assigned to the project since the last report.

Respectfully submitted,

J. W. McCarty
Project Director

APPROVED:

Herschel H. Cudd, Acting Director
Engineering Experiment Station

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA

June 29, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 3
Contractor's Purchase Order G. No. 942
Subcontract to Prime Contract DA-33-008-ORD-568

Gentlemen:

Progress during the period (May 25, 1953, through June 15, 1953) is summarized as follows:

Interim Report No. 1 containing calculations and recommendations regarding an interim improvement over the present parachute design was completed and forwarded to TEMCO, Inc. We were disappointed to learn that the Ordnance Department has issued instructions to stop work on such an interim chute design as we feel that such an interim improvement would be most helpful at this time.

During the period we received a ten-yard cut of Type HH balloon cloth forwarded to us by The Paul K. Weil Company of Saint Louis, Missouri. We are proceeding with a complete test on this material and will forward the results to TEMCO in the near future if this information is desired immediately.

Samples of 36 parachute materials accumulated or woven for Contract No. AF 33(038)-15624, E. O. No. 602-193SR-7S, have been received. Bursting tests have been made on these materials, and we are proceeding with other tests needed to supplement the data contained in the previously mentioned project.

Receipt is acknowledged of your letter of June 12, 1953, stating that the scope of your work had been modified considerably and that you were in a period of planning and reorientation regarding the entire ordnance project. We note your desire of a conference in the near future for the purpose of redefining the scope of the work to be done by The Georgia Institute of Technology in the light of your modified plans. At this time, also, we can determine contractual details as regards scope and material desired for inclusion in our progress reports. We shall look forward to hearing from you about this soon.

There has been no change in personnel since the last report.

Respectfully submitted

J. W. McCarty
Project Director

Approved:

Herschel H. Cudd, Acting Director
Engineering Experiment Station

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA

July 28, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 4
Contractor's Purchase Order G. No. 942
Subcontract to Prime Contract DA-33-008-ORD-568

Gentlemen:

The following is a summary of progress on the subject contract during the period June 16, 1953, through July 15, 1953.

Tests on the ten-yard cut of Type-HH balloon cloth forwarded to us by The Paul K. Weil Company of Saint Louis, Missouri, have been completed. These data will be included in the technical report on this project.

We were pleased to have Mr. Howard Peters and Mr. Lewis Brown of TEMCO, Inc., Nashville, Tennessee, visit with us to confer with the writer, Dr. Fred Cox and Mr. Harry Baker, Assistant Directors, Dr. Fred Bellinger, Head of the Chemical Sciences Division, and Mr. H. W. S. LaVier, Research Associate Professor, all of the Engineering Experiment Station. It is felt that these conferences regarding the scope of the work to be done by The Georgia Institute of Technology under the subject contract did much to clarify the situation.

As a result of these conferences we feel that we can proceed in a logical manner toward the accomplishment of the desired goal. This goal, as we understand it, is the eventual preparation of a Handbook of Parachute Fabrics from which the Ordnance Department may be able to secure quickly information they may need in order to make calculations regarding the details of canopy and/or shroud-line materials for use in illuminating shell parachutes. In order to accomplish this final goal, we are to begin the accumulation of data by a complete literature search for information concerning the aforementioned parachute materials. This, then, should be the first phase of our work--that is, the detailing of available information on the subject from whatever source it may be found.

Subsequent phases of the work would include the accumulation of such additional data found necessary to complete the catalog of properties. For example, data will probably be needed on flammability, packing volume, effect of set-back on strength of folds, and resistance to aging and temperature cycling. In order to obtain these data, new equipment and techniques may require development.

Accordingly, we are proceeding along these lines and, in view of the changed program, are mapping plans for making changes in personnel which will switch the emphasis from laboratory test work to a combination of library searching and laboratory testing.

We expect to complete these personnel changes in the very near future so that the first phase of the program may be expedited.

The difficulty of obtaining the needed canopy and/or shroud-line materials for test purposes will probably require the design and weaving of special lots of material. It is also anticipated that the assistance of TEMCO and Ordnance will be needed to secure certain commercially available materials.

We appreciate very much the splendid cooperation being given to us by TEMCO.

Respectfully submitted,

J. W. McCarty
Project Director

Approved:

Herschel H. Cudd, Director
Engineering Experiment Station

Proj 237

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA

August 25, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 5
Contractor's Purchase Order G. No. 942
Subcontract to Prime Contract DA-33-008-ORD-568

Gentlemen:

Work during the period July 15, 1953, through August 15, 1953, is summarized briefly here.

The personnel of the project has been changed in light of the changes in procedure occasioned by the reorientation of the prime contract. To expedite the extraction of pertinent data from various sources, Mr. Allen Wastler, a graduate engineering student, has been added to the project as a Research Assistant, and Mr. Richard Ferster, a senior Textile Engineering student, has been added to the project as a part-time Student Assistant. Mrs. Fern Stiltner, a laboratory technician, has been transferred from the project.

The fourteen samples of nylon cord stitched to canopy fabric and tape, forwarded to us by TEMCO, have been tested for stitching strength. The table below gives the results of these tests and the observations recorded at the time of each break.

Sample Number	Length of Stitch (Inches)	Breaking Strength (Pounds)	Observations
Single Zig-Zag Stitch:			
A	1.0	120	Stitch broken and/or pulled out
B	1.5	170	Stitch broken and/or pulled out
C	2.0	152	Stitch broken and/or pulled out
D	2.5	265	Stitch broken and/or pulled out
E	3.0	210	Stitch broken and/or pulled out
F	3.5	235	Stitch broken and/or pulled out
G	4.0	282	Canopy and tape broken--stitch intact
Double Zig-Zag Stitch:			
R	1.0	280	Canopy and tape broken--stitch intact
S	1.5	270	Canopy and tape broken--stitch intact
T	2.0	202	Canopy and tape broken--stitch intact
U	2.5	292	Canopy and tape broken--stitch intact
V	3.0	195	Canopy and tape broken--stitch intact
W	3.5	270	Canopy and tape broken--stitch intact
X	4.0	287	Canopy and tape broken--stitch intact

Respectfully submitted,

J. W. McCarty
Project Director

Approved:

Herschel H. Cudd, Director
Engineering Experiment Station

[redacted]

Proj 237

GEORGIA INSTITUTE OF TECHNOLOGY

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA

September 16, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 6
Contractor's Purchase Order G. No. 942
Subcontract to Prime Contract DA-33-008-ORD-568

Gentlemen:

During the past month (August 15, 1953, to September 15, 1953) we have continued the literature survey which was started after our reorientation conference with Temco representatives in July.

We have found in the course of this literature search that many fabrics suitable for parachute use have been studied with regard to one property or another, but complete data on any one fabric are not given in any of the literature so far examined.

We have, up to this time, examined the following abstract journals for the dates indicated:

The Industrial Arts Index - January, 1940, through August, 1953

The Engineering Index - 1945 through 1952

Air University Periodical Index - October, 1949, through March, 1953

Aeronautical Engineering Index - 1947 through August, 1953

N.A.C.A. Index - 1915 through 1949

Aeronautical Card Index - 1947 through August, 1953

Classified List of OTS Printed Reports - from end of World War II through October, 1947

Technical Index of Reports on German Industry - 1945 through 1948

In addition to these, several reports of the Georgia Tech Engineering Experiment Station and of the Armed Services Technical Information Agency have been obtained and examined for related information.

The bibliographies of articles pertinent to the subject have also been checked for references which might possibly have been omitted from the abstract journals.

Information on the properties of specific fabrics have been recorded from the articles examined, and abstracts have been prepared for each pertinent article encountered. The data thus obtained are being classified and correlated according to fabric and property, and a cross-reference index is being prepared.

Representatives of Georgia Tech are planning to attend the Parachute Symposium to be held at the Wright Air Development Center in Dayton, Ohio, on September 21st and 22nd. Plans have been made to visit the Armed Services Technical Information Agency Document Center at that time to check the availability of additional information relative to the current literature search.

Tensile strength and denier determinations have been completed on the sample of fiber-glass material recently forwarded to us, and we expect to make the air permeability tests on this sample in the near future, as well as tests on the two additional fabric samples submitted.

Respectfully submitted,

[redacted]

J. W. McCarty
Project Director

Approved:

[redacted]

Herschel H. Cudd, Director
Engineering Experiment Station

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA

October 20, 1953

TEMCO, Incorporated
Nashville, Tennessee

Attention: Supervisor
Research and Development

Subject: Progress Report No. 7
Contractor's Purchase Order G. No. 942
Subcontract to Prime Contract DA-33-008-ORD-568

Gentlemen:

The following is a summary of the work during the past month (September 16, 1953, through October 15, 1953).

On September 21 and 22 the writer and Professor LaVier attended the Symposium on Parachute Textiles conducted by the Materials Laboratory of the Wright Air Development Center in Dayton, Ohio. It is felt that this was a most worthwhile meeting and that some good for the project was accomplished. Among the reports of this symposium was one by the Radioplane Corporation on a project for the Parachute Branch of the Materials Laboratory of Wright Air Development Center. This project included a thorough literature search on parachute textiles. Arrangements are under way to secure an advance of the publication copy of the bibliography of the above-mentioned project.

In the meantime, work has been completed on the library listings available here at Georgia Tech. We are attaching to this two specimen pages of data accumulated during this literature search, one on yarn and the other on fabric. These pages are included merely to give an indication of the type of data taken during this summary. Suggestions for the inclusion of additional data or the exclusion of some of the data shown will be appreciated.

We are happy to report that the permeometers are back in operating condition. We regret the delay in securing data on the Fiberglas fabrics forwarded to us for testing. We have now completed the requested physical tests on the one sample (SM-100) and the air permeability tests on the three samples (SM-100, SM-106, SM-108). The results of these tests are also attached.

Respectfully submitted,

J. W. McCarty
Project Director

Approved:

Herschel H. Cudd, Director
Engineering Experiment Station

Attachments:

A. Physical Tests on Sample SM-100
B. Air Permeability Tests on SM-100, SM-106, SM-108.
C. Specimen of Yarn Data
D. Specimen of Fabric Data

ATTACHMENT A

PHYSICAL TESTS ON SAMPLE SM-100

Test Number	Breaking Strength Warp Grab Method (Pounds)	Breaking Strength Filling Grab Method (Pounds)	Thickness (Inches)	Weight 3 x 3 Sample (Grams)	Fabric Weight (Ounces Per Sq. Yd.)
1	29.0	11.5	0.0015	0.1665	0.846
2	19.0	19.25	0.0015	0.1641	0.834
3	19.0	11.5	0.0015	0.1642	0.834
4	28.5	10.0	0.0015		---
5	19.5	9.0	0.0015		---
Total	115.0	61.25	0.0075		2.514
Average	23.0	12.25	0.0015		0.838

ATTACHMENT B

AIR PERMEABILITY TESTS

SM-106		SM-108		SM-100	
Cloth Static Pressure (Inches H_2O Gage)	Permeability (Std. cfm Per Sq. Ft.)	Cloth Static Pressure (Inches H_2O Gage)	Permeability (Std. cfm Per Sq. Ft.)	Cloth Static Pressure (Inches H_2O Gage)	Permeability (Std. cfm Per Sq. Ft.)
1	1145	3	758	1	797
2	1622	5	985	2	1140
3	1973	7	1138	4	1580
4	2281	10	1351	6	1920
5	2567	15	1625	8	2220
6	2795	20	1865	10	2450
7	3027	25	2075	12	2660
8	3238	30	2260	14	2880
9	3445	35	2459	16	3070
10	3638	40	2621	18	3210
11	3778			20	3410

Note: Cloth static pressure and permeability results shown above are averages for nine samples.

Highest static pressure shown for each fabric represents machine capacity for that fabric.

TEMCO, Incorporated

October 20, 1953

ATTACHMENT C

SPECIMEN OF YARN DATA

Name Type 200

Yarn Description 30 den., 10 fil. ½ z semi-dull

Fiber Nylon

Manufacturer DuPont

	At				After 24-hr. Exposure			
Test Conditions	-70°F	65%RH 70°F	210°F	350°F	-70°F	210°F 95%RH	210°F 2% RH	350°F
Breaking Strength (gm./den.)	8.0	4.7	3.1	2.3	4.3	4.7	4.5	---
Tenacity (Yield) (gm./den.)	1.2	0.8	---	---	---	---	---	---
Ultimate Elongation (%)	11.4	18.9	13.8	26.0	18.4	24.5	17.8	---
Loop Strength (gm./den.)	---	4.5	3.2	---	---	---	---	---
Loop Efficiency (%)	---	96.0	100.0	---	---	---	---	---
Initial Modulus (gm./den.)	104.0	36.0	17.0	11.0	---	30.0	33.0	---
Yield Point Elongation (%)	1.2	2.3	---	---	---	---	---	---
Shrinkage (%)	---	---	---	---	---	5.2	4.8	---

ATTACHMENT D

SPECIMEN OF FABRIC DATA

Name GT-61 Construction 126 x 83

Color White Weight (oz/yd^2) 1.530

Twist (TPI) W 7.8 z Yarn Size W 45.28/13

F 1.3 z F 73.92/34

Fiber unfinished nylon Elongation (%) W 22.8

Tensile Strength W 44.4 F 21.4

F 80.4 Weave Plain

Static Pressure Upstream of Cloth (Inches Water)	Mass Velocity of Air Upstream of Cloth ($lbm/sec\text{-}ft^2$)	Relative Porosity of Cloth (Per Cent)	Volumetric Velocity (cfm/ft^2)
50	2.50	7.85	1955
45	2.36	7.77	1858
40	2.20	7.76	1740
35	2.04	7.72	1615
30	1.87	7.70	1497
25	1.69	7.66	1362
20	1.49	7.54	1210
15	1.27	7.54	1035
10	0.965	7.05	791
7	0.816	7.12	673
3	0.444	5.97	367

ENGINEERING EXPERIMENT STATION
of the Georgia Institute of Technology
Atlanta, Georgia

FINAL REPORT

PROJECT NO. 237-208

EXPERIMENTAL INVESTIGATION OF MATERIALS FOR PARACHUTES FOR ILLUMINATING SHELLS

70

By

J. W. McCARTY

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CONTRACTOR'S PURCHASE ORDER G NO. 942
SUBCONTRACT TO PRIME CONTRACT DA-33-008-ORD-568

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DECEMBER 31, 1953

ENGINEERING EXPERIMENT STATION
of the Georgia Institute of Technology
Atlanta, Georgia

FINAL REPORT

PROJECT NO. 237-208

EXPERIMENTAL INVESTIGATION OF MATERIALS FOR PARACHUTES FOR ILLUMINATING SHELLS

By

J. W. McCARTY

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CONTRACTOR'S PURCHASE ORDER G NO. 942
SUBCONTRACT TO PRIME CONTRACT DA-33-008-ORD-568

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DECEMBER 31, 1953

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I. OBJECT

This project was established to investigate various materials that might be used in fabricating parachutes for illuminating shells of various types and calibers. The end product was to be a report containing the available data, parameters and observations that may be useful in the design of these parachutes. The study was to include an investigation of all material that might be suitable for parachute canopies and parachute shroud lines.

Because of the sudden termination of the project, time did not permit completing the original object. This report is concerned almost entirely with tabulating the available data accumulated by the literature search.

II. SUMMARY

The work on this project began on April 1, 1953, with the initiation of the contract. The month of April was spent in securing personnel for the project and in studying the details of the project so that a logical and orderly procedure could be planned.

The program of work was set aside during the month of May, 1953, in order that an interim improvement of the present parachute design might be developed. This work resulted in Interim Report No. 1 dated June 1, 1953.

Work under the original program during the month of June, 1953, consisted of testing several fabrics accumulated under an Air Force project to secure additional data which were considered important to the work of the subject contract. The results of these tests are included in appendix B of this report.

By early July, the scope of the work to be done by TEMCO, Inc., under the prime contract had been considerably modified by the Ordnance Department, and the results of these changes necessitated certain changes in our subcontract. Since Ordnance desired a Handbook of Parachute Materials, the project personnel conferred with TEMCO, Inc. personnel for a briefing about the new scope of the work to be done. It was decided that the first phase of the work under this new program would be a complete literature survey of the work that had already been done on these materials. Accordingly, a comprehensive literature search was started, extending from that time through the month of October, 1953.

The local phase of the literature search had just been completed when, on October 28, 1953, the Engineering Experiment Station was notified of the termination data of the contract. Since that time the project personnel have proceeded to do as much as possible in the way of summarizing and correlating the data accumulated in the course of this survey. Unfortunately, the time available for this correlation has not been sufficient to permit completing the job. In addition, arrangements have been made to secure an advance copy of the report WADC TR 53-78 of a similar literature search made by the Radioplane Corporation for the Parachute Branch of the Wright Air Development Center of Dayton, Ohio. Unfortunately, these data were not available for inclusion in this report.

In addition to conducting the work summarized above, the Engineering Experiment Station cooperated with TEMCO in testing various items needed in their work on this contract. Accordingly, in the monthly letter for August the results of tests on several different seams were reported. The October letter included the results of tests on three samples of Fiberglas material.

Since the results of these tests and the interim improvement design have been reported previously, they are not included in this report.

Shortly before the announcement of the project termination work had been started on a study measuring the "packability" or compressibility of parachute materials. A simple machine to test for this factor had been designed and was being constructed. Project personnel were forced by the termination to abandon this project until such a time as the work may be reinstated.

III. RESULTS

As a consequence of changing the scope three times during the nine months' duration of the subject contract, the results available for inclusion in this final report are meager. It is felt, however, that valuable work has been accomplished; the project eventually should be able to assist the Ordnance Department with the problems of the specifications for, and design of, illuminating-shell parachutes.

Hence, this report presents a summary and some general correlations of the various data collected by the literature search. Unfortunately, time would not permit a more comprehensive summarization, and the afore-mentioned Radioplane Corporation report was not received in time to include the additional data it contained.

So far, the work done under the subject contract merely provides a base upon which the work of testing and correlation could be developed.

IV. LITERATURE SEARCH

A literature search was conducted to determine how much data had been recorded on the properties of fabrics suitable for parachute canopies. Several abstract journals were examined under the appropriate headings. The journals examined and the periods through which they were studied were:

<u>The Industrial Arts Index</u>--January, 1940, to August, 1953,

<u>The Engineering Index</u>--1945 through 1952,

<u>Air University Periodical Index</u>--October, 1949, through March, 1953,

<u>Index Aeronauticus</u>--1945 through 1952,

<u>Aeronautical Engineering Index</u>--1947 through August, 1953,

<u>N. A. C. A. Index</u>--1915 through 1949,

<u>Aeronautical Card Index</u>--1947 through August, 1953,

<u>Classified list of OTS Printed Reports</u>--From the End of World War II to October, 1947,

<u>Technical Index of Reports on German Industry</u>--1945 to 1948.

Several reports of the Engineering Experiment Station of the Georgia Institute of Technology were examined for pertinent information, and other reports were obtained from the Armed Services Technical Information Agency and the Wright Air Development Center. The bibliographies of articles on the subject were also checked for references which might possibly have been omitted from the abstract journals and indexes examined.

As the literature search proceeded, information on the properties of specific fabrics and yarns was copied from the articles examined, and abstracts were prepared for each pertinent article.

Appendix A contains a listing of those references which contain data on the properties of various fabrics and yarns; these references are cited throughout this report. The bibliography consists of sources containing information on the broader subject of parachute design but not including data on particular yarns or fabrics. Each bibliographic item is accompanied by a brief abstract of the article or report.

Appendix B contains 25 tables of fabric and yarn data accumulated during the course of the literature search. An effort was made to evaluate only those yarns and fabrics which have been used, or have been proposed for use, in parachute fabrication. Many fabrics suitable for parachute use have been studied with regard to one property or another, but complete data on any one yarn or fabric were not found to be available. In the tables of data presented in Appendix B, therefore, the accumulated data are grouped according to the type of fiber used and under the following alphabetically arranged headings.

A. Acrilan

Several Acrilan yarns have been tested under a variety of conditions. The results of these yarn tests are summarized in Table I. However, no Acrilan fabrics suitable for parachute use were discussed in the material covered by the survey.

B. Cotton

Tables IIA-IIB summarize the data accumulated from the studies conducted on cotton yarns. The data on those cotton fabrics which might be suitable for parachute use have been summarized in Table III. It will be noted that in many cases only a few tests have been made on a particular fabric. However, it is possible that even limited data on a fabric might be helpful in predicting whether additional testing of similar fabrics should be undertaken.

C. Dacron

Several Dacron yarns have been studied to some extent, and the results of these tests are summarized in Table IVA-IVB. A number of Dacron fabrics have also been studied, emphasizing their physical properties and air permeabilities under varying static pressures. The results of the tests on these fabrics are presented in Tables V, VI, and VII. Those in Table VII are data from air-permeability studies conducted at Georgia Tech under Contract No. AF 33(038)-15624. These data on air permeability give an empirical relation of the form

$$Y = aX^b$$

when plotted on log-log paper and applied only to the pressure range indicated. In the table a and b are given for each fabric studied.

D. Dynel

Several different Dynel yarns have been studied and the results of these studies are summarized in Table VIII. However, no suitable Dynel fabrics were found to have been tested.

E. Fiberglas

The results of studies made on several Fiberglas yarns are summarized in Table IX. The standard cloth constructions and physical data for several Fiberglas fabrics are presented in Table X.

F. Jute Hessian

During World War II jute Hessian was studied as a possible material for the parachutes used to drop large bombs and mines. Only one such fabric was found described in the literature (4). This fabric was listed as having the following characteristics:

Material: bomb parachute fabric,

Construction: 18 x 19,

Weight: 12 ounces per square yard,

Tensile Strength
Warp: 120 to 150 pounds per inch,
Filling: 140 to 170 pounds per inch,

Air Permeability: 0.08 to 0.10 pound per square foot.

G. Nylon

Many nylon yarns and fabrics have been tested to determine their suitability for use as parachute fabrics. The results of the tests on nylon yarns are summarized in Tables XIA-XIF.

Four nylon cords and one rayon cord were tested for possible use as shroud lines. The results of tests on the nylon cords are given below (11).

1. Group I

For data on rayon cord see section I, Rayon.

2. Group II

Description: tubular webbing, similar to specification AN-W-10b (MIL-W-5625)

Construction
Warp: 23 ends
yarn--210/68 nylon, 1/8 (1S/1.9S)
Filling: 24 picks per inch
yarn--210/68 nylon, 1/4 (12S/2.1S),

Breaking Strength: 517 pounds,

Ultimate Elongation: 23.1 per cent,

Permanent Set (per cent elongation after 24 hours):
4.6 (from 90 per cent of rated strength loading),

Load:	100	200	300	400	500,
Per Cent Elongation:	9.6	14	17	19.4	21.8

3. Group III

Description: shroud line, MIL-C-5040, type III (AN-C-63),

Construction: 26 picks per inch
yarn size--84.2 yards per pound,

Breaking Strength: 586 pounds,

Ultimate Elongation: 39.3 per cent,

Permanent Set (per cent elongation after 24 hours):
10.3 (from 90 per cent of rated strength loading),

Load:	100	200	300	400	500	550,
Per Cent Elongation:	14.4	21.6	26.9	30.9	34.5	36.6.

4. Group IV

Description: nylon shroud line, core and sleeve,

Construction
Cover (sleeve): 28 picks per inch, 32-carrier braider,
yarn--70/34 nylon, 1/2/3 (1Z/20.2S/13Z),

Core: 4 ends
yarn--210/34 nylon, 1/5/3 (1Z/10.5S/5.9Z),

Breaking Strength: 336 pounds,

Ultimate Elongation: 41.8 per cent,

Permanent Set (per cent elongation after 24 hours):
11.0 (from 90 per cent of rated strength loading),

Load:	50	100	150	200	300,
Per Cent Elongation:	13.8	21.0	26.4	30.7	37.8.

5. Group V

Description: Formic-acid-treated cord, MIL-C-5040, type III (AN-C-63). Seven hundred-yard skeins of nylon shroud line were treated in a solution of 30 per cent formic acid for 15 minutes. The line was removed, washed four times, and the remaining traces of acid neutralized with soda ash. The line was given a final rinse and dried. The treatment shrinks the line.

Construction: shroud line, MIL-C-5040, type III (AN-C-63) (same as group III),

Breaking Strength: 580 pounds,

Ultimate Elongation: 52.8 per cent,

Permanent Set (per cent elongation after 24 hours):
15.0 (from 90 per cent of rated strength loading),

Load:	100	200	300	400	500	550,
Per Cent Elongation:	19.7	29.7	36.6	42.0	46.8	49.8.

6. Other Data

Using these five groups of shroud lines, the air permeability of parachutes was studied at different launching speeds for two canopy sizes. The canopies were made of nylon fabric, specification MIL-C-7020, type I. This is a rip stop material weighing 1.1 ounce per square yard. The results of these tests are given in Table XV.

Numerous tests on nylon fabrics were found in the course of the literature search. The data accumulated from a study of these references are summarized in Tables XII, XIII, XIV, and XVI. Those in Table XVI are the results of air-permeability studies conducted at Georgia Tech under Contract No. AF 33(038)-15624. These data on air permeability give an empirical relation of the form

$$Y = aX^b$$

when plotted on log-log paper and applied only to the pressure range indicated. In the table a and b are given for each fabric studied.

H. Orlon

Data on the Orlon yarns tested have been summarized in Table XVIIA-XVIIB. Data on those Orlon fabrics which had been tested, and reported are summarized in Tables XVIII, XIX, and XX. Those in Table XX are data from air-permeability studies conducted at Georgia Tech under Contract No. AF 33(038)-15624. These data on air permeability give an empirical relation of the form

$$Y = aX^b$$

when plotted on log-log paper and applied only to the pressure range indicated. In the Table a and b are given for each fabric studied.

I. Rayon

The data obtained in testing some rayon yarns are summarized in Tables XXIA-XXIB.

There was one shroud-line material tested; the results of the tests are as follows:

Description: Fortisan shroud line, similar to specification 16142, type II,

Construction
Cover (sleeve): 17.5 picks per inch, 40-carrier braider, yarn--90/120 Fortisan H. T., 1/6 (2.5S/2.0Z),

Core: 4 ends
yarn--270/120 Fortisan H. T., 1/2/12 (2.4S/4.9S/2.1Z),

Breaking Strength: 464 pounds,

Ultimate Elongation: 8.7 per cent,

Permanent Set (per cent elongation after 24 hours):
4.0 (from 90 per cent of rated strength loading),

Load:	100	200	300	400	450,
Per Cent Elongation:	5.1	6.1	6.9	7.6	8.1.

Measurements of the effect on air permeability of different shroud lines and launching speeds for this type of cord are given in Table XV. Data on the physical and textile properties of rayon fabrics are summarized in Table XXII.

J. Silk

Data on silk yarns which have been studied for various properties at varying conditions are presented in Tables XXIII and XXIV. Data obtained from studies of silk fabrics are summarized in Table XXV.

V. RECOMMENDATIONS FOR FUTURE WORK

It should be re-emphasized that the work accomplished so far has been primarily of an exploratory nature, and that the experimental program of the subject problem is now ready for development.

There is much work to be done on the problems of selecting materials for, and designing, parachutes to be used with illuminating shells. Such factors as the packability of the materials, the effect of set-back on the strength of the folds, selecting the canopy materials which have the necessary strength to withstand the opening shock and yet give the proper rate of descent, selecting materials with the necessary temperature resistance to withstand storage at subfreezing temperatures and also to withstand the high temperatures induced during discharge of the guns and shells--these and many other factors need study before the body of data will be complete enough to determine the proper size, shape and materials for illuminating-shell parachutes.

Respectfully submitted:

J. W. McCarty
Project Director

Approved:

Herschel H. Cudd, Director
Engineering Experiment Station

VI. APPENDIX

APPENDIX A

References Cited and Bibliography

REFERENCES CITED

1. Anonymous, "Parachutes and The New Fabrics They Require." Textile World 93, No. 10, 65-8 (October 1943).

   This article presents an over-all picture of the many different types of parachute fabrics being used by the armed forces at this time.

2. Appel, W. D., and Worner, R. K., An Investigation of Cotton For Parachute Cloth. N.A.C.A. Bulletin No. 393, Washington, 1931, 21 pp.

   Cotton yarn of high strength in proportion to its weight and otherwise specially suitable for parachute cloth was developed. Cloth woven from this yarn was equal to or superior to parachute silk in strength and tear resistance, met the requirements with respect to air permeability, and weighed only a few tenths of an ounce per square yard more than the silk cloth. Practical trials indicate that the cotton parachute closely approaches the silk parachute in performance as to rate of descent, opening time, strength and ability to function when stored in the pack for sixty days.

3. Brown, W. D., The Effect of Tension on The Porosity of a Parachute Fabric. A.R.C. Technical Report, R. & M. No. 2325, London, 1949, 10 pp.

   A number of parachute fabrics were tested, covering various types of weave. Experiments were made with the fabric pulled along warp and filling while its porosity was measured at 5 and 10 inches of water.

   In every tension test the fabric failed to return to its original dimensions on releasing the load. The porosity of some fabrics increased steadily with load, some did not change, and others decreased with load. The type of weave appeared to have no effect on the change of porosity with load. The relation between porosity and extension appears to be independent of whether the load is being increased or decreased. Plots are given of porosity vs. load, per cent extension vs. load and porosity vs. per cent extension.

4. Brown, W. D., and Harrison, K., Design of Parachutes For Large Bombs. A.R.C. Technical Report, R. & M. No. 2324, London, 1949, 22 pp.

   The aim of this work has been to develop a parachute to control a heavy bomb which is itself unstable. A jute Hessian parachute has been found to be satisfactory.

Experiments using parachutes up to 20 feet in diameter have produced enough data to draw a series of curves giving the safe speeds for releasing bombs fitted with jute Hessian parachutes and also giving the striking velocities of such bombs. A standard parachute design has been evolved.

Important developments include an investigation into the effect of the relative extension of the shroud lines and the canopy fabric on the strength of the parachute under shock loading and a search for alternative materials to jute Hessian.

5. Brown, W. D., and Holford, J. F., Porous Properties of Various Materials Liable To Be Used For Making Parachutes. A.R.C., C.P. 1-25, No. 24, Great Britain, 1950, 21 pp.

An investigation has been made into the porous properties of paper of paper perforated with round holes and ribbon meshes with square interspaces. It has been established that the relationship between porosity and the porous area is almost linear for all materials.

An approximately straight line law exists between the logarithm of the porosity and the logarithm of the pressure difference across the sample being tested, whether that sample is a woven fabric or a ribbon mesh.

The value of the index x in the expression $v\gamma p^{x/2}$ is lower for a ribbon mesh than for a woven fabric. Woven fabrics of natural fibers have a higher index value than woven fabrics of artificial fibers.

6. Busse, W. F., Lessig, E. T., Loughborough, D. L., and Larrick, L., "Fatigue of Fabrics." Journal of Applied Physics 13, No. 11, 715-24 (1942).

The effect of temperature and time of application of load on the growth and apparent tensile strength of fabrics was studied. The results gave some information about the mechanism of failure of mechanical fabrics at low loads in service which could not be obtained with standard textile tests.

A fatigue test was developed which measured the lives of samples at elevated temperatures while subjected to a constant average load and a superimposed cyclic stress. The change in life with temperature on this test is enormously greater than the change of tensile strength with temperature.

7. Cleary, C. J., "Textiles in Aeronautics." Textile Colorist 63, No. 1, 25-8 (January 1941).

This article presents a picture of the requirements of fabrics for aeronautical uses and lists some of these fabrics and possible substitutes for them.

8. Coplan, M. J., A Study on The Effect of Temperature on Textile Materials. WADC Technical Report 53-21, Wright-Patterson Air Force Base, Ohio, March, 1953, 172 pp.

The main purpose of this investigation was to evaluate the fibers at temperatures from -70° F. to the extremely high temperatures at which the fibers fail to function efficiently. (This temperature ranges from 300° F. to 375° F.) To make the evaluation complete in itself, such properties of the yarns as average breaking tenacity, average breaking elongation, average yield tenacity, average yield elongation, average initial modulus, average loop tenacity and efficiencies, energy absorbed to several stress levels, and heat shrinkage were obtained at various temperatures and after exposure for specific lengths of time at each temperature. Detailed data are given in both tabular and graphic form, as well as a discussion covering the mechanical behavior of fibers.

The yarns studied were: nylon, Orlon, Dacron, Fortisan, Tenasco, Vinyon (NORU, NOHU), Janapese gum silk, Fiberglas, Acrilan, Dynel, and cotton, greige and mercerized.

9. Etchells, A. W., "Some Effects on Dry Heat Upon The Properties of Nylon Fabrics." American Dyestuff Reporter 35, 38-42 (January 14, 1946).

The shrinkage, tensile strength, breaking elongation and dyeing properties of some nylon fabrics were studied after exposures of 5, 10 and 15 seconds to temperatures of 300°, 350°, 400°, 450° and 470° F.

The conclusions drawn were: (1) Nylon shrinks when heated, and this shrinkage can be fixed by the use of dry heat. The higher the temperature of treatment or the longer the time, the more permanent the "set." (2) Nylon can be damaged by dry heat. This damage is indicated by a loss in tensile strength and elasticity. The fiber is also made yellower in color by the higher temperatures. (3) Heat-treated nylon fabrics can be dyed without forming creases in the fabric, provided the temperature of pretreatment is sufficiently high. (4) Some dyestuffs dye heat-damaged nylon to a greater depth than undamaged nylon, whereas other dyes show a loss in color value with increasing temperature of pretreatment.

10. Gagliardi, D. D., and Nuessle, A. C., "The Relation Between Fiber Properties and Apparent Abrasion Resistance." American Dyestuff Reporter 40, No. 13, 409-15 (1951).

The modification of fabric properties brought about by treatment with stabilizing and creaseproofing compounds has been shown to be related directly to changes in stress-strain properties of the fibers.

11. Gimalouski, E. A., Investigation of Impact Load Absorption Through Suspension Line Elongation. WADC Technical Report 52-57, Wright Air Development Center, December, 1952, 224 pp.

The objective of this investigation was the study of suspension lines under actual operating conditions, measured at varying degrees of elongation, energy absorption and elasticity. A secondary purpose was the study of fabric porosity, shape and type of canopy and method of parachute deployment.

The shock-absorbing capacity of five different types of parachute suspension line cord were first evaluated for basic typical properties; then they were tested by assembling into parachutes and opening the parachute at various speeds--first at 100 mph, then 150 mph, finally 200 mph--on a whirling test tower. The parachutes were evaluated first in standard back type, then in deployment bag openings. Two types of parachutes were used: one was a 24-foot standard parachute, the other a 30-foot parachute with an extended shirt.

The loads were measured and the cords evaluated on the basis of shock-absorbing capacity, strength and durability. Final results of the work indicate that the presently used 550-pound-tensile-strength cord, specification MIL-C-5040, type III, is the best of the cords evaluated. A good correlation was established between the line energy and the snatch force, but opening shock loads appear to be little affected by line characteristics.

12. Goglia, M. J., Air Permeability of Parachute Cloth. Technical Report No. 1, Project No. 170-117, State Engineering Experiment Station, Georgia Institute of Technology, Atlanta, 1952, 135 pp.

The air permeability of eight standard nylon parachute cloths was determined using a sample 6.05 inches in diameter in a wind tunnel whose capacity permitted obtaining static pressure differentials across the cloth as high as 55 inches of water. Fifty-nine experimental nylon cloths manufactured by the Bally Ribbon Mills were subjected to the same test, as well as two experimental fabrics of Orlon and Dacron, respectively.

Some theoretical work on the relation of the geometry of the cloth to the flow of air and the pressure gradient is presented.

13. Hamburger, W. J., "Effect of Yarn Elongations on Parachute Fabric Strength." Rayon Textile Monthly 23, No. 3, 151-3, No. 5, 291-2, No. 6, 332-4 (March, May, June 1942).

Various types of fabrics are discussed in connection with the effect of yarn elongation on parachute fabric strength. Fortisan, nylon and silk are compared as to per cent elongation, tensile strength, Mullen burst pressure and impact strength.

14. Heinrich, H. (Translated by R. Widmer), Development of Parachutes for Bombs, Mines, and Torpedoes. Translation 215, The David W. Taylor Model Basin, Navy Department, Washington, 1949, 45 pp.

The report is a summary of German work on the development of parachutes having characteristics suitable for use in dropping mines, bombs and torpedoes. The work was directed toward the development of parachutes of high strength, high stability during descent and low opening shock. This report reviews the work done and does not contain detailed descriptions of the various operations involved.

15. Hotte, G. H., "An Investigation of Fabric Structure and Its Relation to Certain Physical Properties." Textile Research Journal 20, No. 12, 811-27 (1950).

This research is concerned with the study of the breaking load and ultimate elongation characteristics of combination fabrics as a function of the load elongation characteristics of their component fabrics.

16. Johns, T. F., Parachute Design. A.R.C. Technical Report, R. & M. No. 2402, London, 1951, 27 pp.

This report records the methods of parachute design which were developed in Great Britain during the latter part of the war. It begins with a discussion of the main characteristics of a parachute and of the effects of various factors on these characteristics. It then describes the main types of parachutes which are in use at present and discusses the merits of each type. Details are given of the methods of manufacture which have been found to be the most satisfactory.

It is then shown how this information is used in the design of parachutes. In particular, the report indicates how to decide which shape of parachute should be used to meet specific requirements. It is shown that parachutes may be divided broadly into two classes, those which open at approximately their release speed and those which slow down their load appreciably before becoming fully inflated. The design techniques in the two cases are quite different, and they are therefore treated separately.

If parachutes are to be mass-produced, the design techniques must be modified seriously because of the variation of porosity which occurs when fabric is made in larger quantities.

An indication is given of the degree of accuracy which can be expected from the methods described, and possible refinements of the design techniques are suggested for use when more accurate data are available regarding the performance of parachutes. No attempt is made to deal with unconventional designs or with clusters of parachutes.

The limitations of the methods of design are discussed, and finally some suggestions are made for future research.

17. Johns, T. F., and Auterson, E. I., The Effects of Various Factors on Parachute Characteristics. A.R.C. Technical Report, R. & M. No. 2335, London, 1950, 25 pp.

Tests were made in a 24-foot wind tunnel to determine how the drag, critical opening speed and stability of a parachute are affected by changes in the design and in the porosity of the parachute fabric.

As a result it has been confirmed that increase of porosity causes a decrease in drag, the change being about 40 per cent over the range of porosities normally covered by the various parachutes fabrics. Other factors have only small effects on drag coefficients. Critical opening speed is mainly dependent upon porosity, being higher when a less porous fabric is used, but it also depends on a number of other factors including shape. The critical opening speed may be increased by increasing the number and length of rigging lines, by closing the vent and by attaching the rigging lines to the circumference of a rigid ring.

Plots are given of the variation of drag with porosity, drag vs. parachute diameter, drag vs. length of rigging lines, drag vs. speed, critical opening speed vs. parachute diameter and others of the varying factors studied.

18. Kaswell, Ernest R., "Low Temperature Properties of Textile Materials." American Dyestuff Reporter 38, No. 2, 127-34 (1949).

High-altitude flying as well as Artic and Antartic military operations requires a knowledge of the performance of filamentous materials and other high polymers at temperatures as low as -70° F. Previous investigations of parachute suspension lines and their component members under standard humidity and temperature conditions have shown requisite properties to be maximum energy absorption, minimum weight and bulk, and minimum shock load to a jumper. Energy absorption may be directly obtained by measuring the area under a load vs. per cent elongation diagram. As temperature is reduced, the normal thermoplastic polymer becomes increasingly stiff and brittle, i.e., its elongation diminishes while its strength usually increases. Since polymeric materials such as nylon, silk and rayon creep or deform when subjected to a stress, rate of loading must also be considered. Yarns which have high elongation and energy absorption, when tested at slow laboratory rates of speed (pulling jaw speed of 12 inches per minute), may lose appreciable elongation and energy when attenuated at impact speeds of 26 feet per second. The combined effect of impact loading and subzero temperature may produce changes which may be enormous.

Data are presented on the mechanical properties of silk; undrawn, partially drawn and fully drawn nylon; Fiber A and Vinyon E when tested under "slow" and impact loading at room temperature and at -70° F. Since, in use, many of these materials must withstand more than one loading, the effect of repeated mechanical stressing under these temperature conditions is also discussed.

19. LaVier, H. W. S., Air Permeability of Parachute Cloths. WADC Technical Report No. 52-283, Part 2, Wright Air Force Base, 1952, 134 pp.

The air permeability of special woven nylon, Orlon and Dacron, parachute-type fabrics was determined using a sample 6.05 inches in diameter. The permeometer used in this program permitted testing samples at pressure differentials across the cloth of as much as 55 inches of water. The 61 experimental cloths woven at Georgia Tech were subjected to this test procedure, as well as the fabrics previously reported in part of one of this report.

Air permeability for all of the cloths tested are presented in graphical form as volumetric flow vs. static pressure across the cloth.

The number of ends per inch in the warp, the number of picks per inch in the filling and the denier of the yarns were found to affect the air permeability of these fabrics. The finishing of fabrics was found to affect the permeability of the fabrics more than any other one of the many variables involved. The tests to determine the effect of the variation of weave pattern failed to show significant differences on this account.

20. Lohmann, H., Investigations on The Strength of Impregnated Parachute Fabrics. AAF Translation TS-760, No. F-TS-760-RE, September, 1946, 10 pp.

Impregnated parachute silks, after various types of storage, were investigated as to their tensile strength. Flame tests on these silks in contrast to unimpregnated silk, showed that the flame is immediately extinguished. As a result of the impregnation, the tensile properties were decreased, and the weight per square meter was increased by 6 to 10 per cent. On a result of this test series it does not seem advisable in principle to impregnate parachute silks.

21. McNichols, H. J., and Hedrick, A. F., The Structure and Properties of Parachute Cloths. N.A.C.A. Bulletin No. 335, Washington, 1930, 34 pp.

The requisite properties of a parachute cloth are discussed, and the methods for measuring these properties are described. In addition to the structural analysis of the cloths, the properties measured are weight, breaking strength, tear resistance, elasticity, and air permeability. Thirty-six silk cloths of domestic manufacture, not previously used in parachute construction, are compared with some silk cloth of foreign manufacture which have been proved by trial and extended use to be suitable materials for parachute construction.

22. Meredith, R., "Properties of Textile Materials." Proceedings of the Textile Institute Journal 43, No. 9, 755-64 (September, 1952); 43, No. 10, 785-92 (October, 1952).

I. The tensile behaviors of various fibers are discussed with their ralations to each other under various conditions of temperature, humidity and duration of loading. Graphs of the properties studied vs. the changing test conditions are presented.

II. The properties of fibers when twisted or bent are discussed in the same way as in the previous part.

23. Millard, F., The Susceptibility of Some Parachute Textiles To Microbiological Attack. A.R.C. Technical Report, R. & M. No. 2309, London, 1949, 6 pp.

The test measured the resultant strength of parachute fabrics after contamination with a mixed microflora obtained from soil (soil-burial test) and exposure to a warm, moist atmosphere. In general, nylon and silk did not lose more than 15 per cent of their strength after 8 days' exposure, whereas mercerized cotton, Celanese strong rayon, viscose rayon and linen lost between 60 and 100 per cent of their strength.

24. O'Hara, F., "Notes on The Opening Behaviour and The Opening Forces of Parachutes." Journal of the Royal Aeronautical Society 53, 1053-62 (November 1949); 54, 132-35 (February 1950).

An approximate theory of parachute opening is suggested. A formula is derived for the critical opening speed (the highest speed at which the canopy develops fully) which indicates variation of the critical speed with fabric porosity, rigging line length, etc., of the order observed in wind-tunnel tests. By assuming a single form for the airflow about the parachute, a formula is also obtained for the rate of opening of a canopy. This permits an analysis of the motion of a gore parachute system during canopy development. The theory confirms the possibility of a large increase with altitude, found experimentally, in the maximum parachute force on the gore.

25. Picken, J., The Effect of Variation of Air Density and Temperature on The Airflow Characteristics of Porous Fabrics. A.R.C., C. P. 1-25, No. 25, Great Britain, 1950, 21 pp.

This note describes a series of tests made at low air densities (corresponding to altitudes of from 0 to 30,000 feet above sea level in 5,000-foot increments) and low temperatures (-50° to 0° C) and establishes that the airflow through porous fabrics obeys the laws of dynamic similarity.

26. Robertson, A. F., "Air Porosity of Open-Weave Fabrics I. Metallic Meshes II. Textile Fabrics." Textile Research Journal 20, No. 12, 838-43, 844-57 (1950).

I. An experimentally verified method is proposed for analyzing porosity data in terms of two dimensionless parameters--the discharge coefficient and Reynolds number characterizing the flow through interyarn pores of a metallic screen. It is shown experimentally that porosity data for wire screens ranging in texture from 8 to 120 wires per inch and in porosities from 30 to 680 $ft^3/ft^2/min.$ can be plotted within rather narrow limits as a single line relating the two dimensionless flow coefficients.

II. A series of 45 different open-weave fabrics has been woven in four weave patterns and a large range of fabric weights and porosities. Laboratory physical data on all these fabrics are shown. Porosity data are presented in dimensionless form, and it is shown that such data for plain, basket and mock leno weaves show a high degree of correlation among themselves. This is not only true for different weave types but also for a wide range of fabric weights. It is shown that the yarn diameter, which is effective in determining the projected fabric open area, depends mainly upon the type of weave, and that for any particular weave the ratio of yarn diameter to the square root of the denier is nearly constant.

The ability to predict effective yarn diameter, for the type of fabrics produced, makes it possible to predict fabric open area and thus the porosity of similarly produced fabrics.

Complete descriptions of the fabrics are given, together with sample calculations illustrating the possibility of predicting fabric porosity.

27. Schenke, E. M., and Shearer, H. E., "Strength and Elongation of Silk Yarns As Affected By Humidity." Journal of Research of the National Bureau of Standards 25, 783-90 (December 1940).

Silk hosiery yarns varying in number of threads from 2 to 9 and in number of turns of twist from 5 to 36 were tested for breaking strength and breaking elongation at 70° F. after various periods of exposure to relative humidities from 33 to 86 per cent. The strengths of the yarns were not affected significantly by changes in relative humidity between 33 and 55 per cent. The yarns were weaker above 55 per cent relative humidity. The elongations of the yarns increased with an increase in the relative humidity of the air. Some data are given on the breaking strength and elongation of one-thread raw silk.

28. Srinagabhushana, "Some Physical Characteristics of Parachute Silk Fabrics." Indian Textile Journal 57, No. 8, 997-1001 (1947).

Various samples of parachute silk fabrics were tested for (1) weight per square yard, (2) resistance to air flow, (3) number of ends and picks, (4) number of turns per inch in the warp and weft threads, (5) yarn crimp, (6) yarn strength, (7) the denier of each end and pick and (8) strength of the fabric. All of the tests used were standard, and the results were recorded as an average of a series of tests.

29. Sullivan, R. R., "Future Study of The Flow of Air Through Porous Media." Journal of Applied Physics 12, No. 6, 503-8 (June, 1941).

The streamlined flow of air through highly porous wads of textile fibers is studied. The rate of flow is found to be twice as great for fibers parallel to flow as for fibers perpendicular to flow. Shape factors for the channels through which the flow takes place are determined and compared with those for the ideal case of Emersleben. The problem of measuring the specific surface of high-porosity wads is discussed.

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1. Alkan, R., "Contributions à l'etude à lessai des Parachutes." Aeronautique 16, No. 179, 37-43 (April 1934).

   This study of the performance of modern parachutes points out the importance of porosity and resilience of parachute tissues, and reports tests of chronophotographic control of parachutes.

2. Bacher, Stanley, The Relationship Between the Structural Geometry of Textile Fabrics and Their Physical Properties P. B. 95956 (Q.M.C. T.S.R. No. 52) August 1948.

   This report is a literature review with tables of data and 36 references. The relationship between structural characteristics and gas permeability is shown.

3. Brown, W. D., Air Flow Through Materials Liable to be Used for Man-Carrying Parachutes with Special Reference to Celanese. E(RAE)TN Aero 1041 Reel 3757 Frame 905, Reel 3780 Frame 603.

   Weight, strength, and porosity of substitute materials for silk in man-carrying parachutes are considered. Cotton proved superior to, nylon similar to and Celanese inferior to, silk.

4. Clayton, F. B., "Measurement of Air Permeability of Fabrics." Journal of the Textile Institute 26, T171-86 (1935).

   Air permeability varies linearly with twist. Increase in picks per inch from 35 to 65 resulted in a linear decrease in permeability of a plain-weave fabric; above 65 the curve flattens out, indicating approach to complete closure. Air permeability was found to vary linearly also with filling count as the filling yarns were increased in size in a plain weave.

   Clayton, in lieu of total air permeability, considers what he calls "sectional" air permeability which is the product of total permeability and the cloth thickness.

5. Cleary, C. J., "Textile Materials Used in Aircraft." Silk Journal & Rayon World 17, No. 198, 21-3 (November 1940).

   This reviews major technical advances and applications of textiles made during the first World War, including performance and properties of parachute fabrics.

6. Cleary, C. J., "Parachute Fabrics." Airway Age 10, No. 11, 1766-8 (November 1929).

The rate at which air flows through the main sail of a parachute has a definite relation to its performance with reference to its rate of descent and its ability to withstand the shock load of opening. The probable limit of permeability is discussed on basis of a series. of tests. Specifications of future fabrics are discussed.

7. Doetsch, H., A Comparison of the Air Permeability of the Material to the Resistance of the Parachute. Z.W.B. /FBI/ 230 Reel 2717 Frame 724, January 1935.

Tests were conducted with various types of material used in the manufacture of parachutes to determine the degree of resistance offered by the different types of cloth.

8. Duncan, W. J., The Cause of the Spontaneous Opening and Closing of Parachutes (The Phenomena of Squidding) Aero. Res. Council Tech. Rept., R. & M. No. 2119 (7293), British Ministry of Supply, December 1943.

An open parachute with a porous canopy will collaspe to a "squid" shape at a critical value of the relative air speed. Upon further reduction of the relative air speed the collasped canopy will re-open at a second (lower) critical speed.

The phenomena are explained on the basis of increased porosity with increased pressure drop through the canopy. The critical speed is higher for longer shroud lines, greater porosity or venting.

If the force of the flow of air (radially) out of the canopy, across its lip, is not greater than the inward radial component of the tension in the shroud lines, the canopy will "squid." The maximum diameter in this condition has been found to be approximately one-third of the maximum diameter (normal, fully extended).

9. Glaskin, A., A Statistical Note on the Variation of Porosity of Nylon Fabric to Specification D.T.D. 556A, A.R.C., R & M No. 2313, British Ministry of Supply, A.R.C., T.N., June 1945.

A large number of porosity (permeability) measurements, at pressure drop of 9.15 inches of water, on twill and plain weave fabrics show that porosity varies across the width but not along the length of a piece of fabric. The minimum porosity occurs at the selvage and the maximum at the center of the width. In general, the average value occurs at a distance of 9 inches from the selvage. (The standard width for this specification is 36 inches.)

By a consideration of probability, it is shown that little is gained by using the average of more than 10 random measurements to establish the mean.

10. Glaskin, A., A Note on the Variation of Porosity of Cotton Fabrics to Specification D.T.D. 562 and D.T.D. 624. E/R.A.E./T.N. Aero. 1664 Reel 3760 Frame 1451.

An investigation of variation of porosity of two types of cotton fabrics used in the manufacture of supply-dropping parachutes was made. Results are shown in graphs and tables.

11. Johns, T. F., and Anterson, E. I., The Porosity of Nylon Fabrics For Man-Carrying Parachutes. E/R.A.E./T.N. Aero. 1176 Reel 3564 Frame 608, April 1943.

Recommendations for porosity for various denier yarn of parachute fabrics made of American nylon yarns are presented.

12. Johns, T. F., Parachute Design. Royal Aircraft Establishment Farmborough, Technical Note No. Arm. 365, December 1946.

This report is a resume of work done on parachutes in general at the Royal Air Establishment, Farmborough, and contains the suggestion that permeability (called porosity in the report) be correlated by plotting v/V against C_D/C_{D_o} where v is velocity of flow through the cloth ($v = 1/2\rho V^2$), V is parachute velocity, C_{D_o} is a constant for a given type of parachute, and C_D is the drag coefficent, i.e.,

$$C_D = \frac{\text{Drag}}{(1/2\rho V^2)\left(\frac{\pi D^2}{4}\right)} .$$

It is suggested that $C_D = C_{D_o}\left(1 - 2.5\ \frac{v}{V}\right)$.

13. Pierce, F. T., "Geometrical Principles Applicable to the Design of Functional Fabrics." Textile Research Journal 17, 123-47 (1947).

Flow resistance is primarily a function of the warp cover factor, provided the weave is firm enough to hold the close warp yarns firmly in place. Flow is proportional to the pressure drop per unit thickness for any shape cross section.

14. Rainard, L. W., "Air Permeability of Fabrics. I." Textile Research Journal 16, 473-80 (1946).

The following relationship is established:

$$F_1\ (\overline{AP}) + F_2 = Pa/\overline{AP}$$

where $\overline{AP}$ is air permeability,
Pa is pressure differential,
F_1 (slope of curve) is dependent on pore radius and number of pores per square inch, and is independent of fabric thickness, and
F_2 (intercept) is dependent on pore radius, number of interstices per inch and fabric thickness.

15. Rainard, L. W., "Air Permeability of Fabrics. II." Textile Research Journal 17, 167-70 (1947).

Discussion of the application of the Haggenbach equation to flow through fabrics. This equation applies to streamline flow through tubes with a correction for kinetic effects.

16. Schiefer, H. E., Cleveland R. S., Porter, J. E., and Miller, J., "Effect of Weave on Properties of Cloth." Bureau of Standards Journal of Research 11, 441-51 (1932).

Air permeability is lower in firm, closely woven cloth having a large number of thread interlacings per unit area and short floats than in cloths of the same weight which are loosely woven, sleazy, with a small number of threads interlacing per unit area and long floats. For a given texture, sateens possess the highest permeability followed in order by herringbone twill, modified herringbone twill, oxford and plain weave.

17. Siemenske, M. A., and Hotte, G. H., "The Permeability of Fabrics. I." Rayon Textile Monthly, 68-70 (January 1945).

A detailed bibliography and a discussion of the development of permeability test methods and apparatus is presented. General methods were: (1) volume of air passing through unit area in unit time, (2) back pressure at a given rate of air passage and (3) rate of flow under a given pressure drop through fabric.

18. Siemenske, M. A., and Hotte, G. H., "The Permeability of Fabrics. II." Rayon Textile Monthly, 61-2 (March 1945).

(a) Permeability increases with the tension in the fabric.
(b) Permeability decreases with the time of flow (because of dirt clogging pores, matting of fibers, etc.).
(c) An increase in temperature should result in increased permeability.

(d) No data are shown for the effect of absolute pressure.
(e) The permeability at three per cent relative humidity was six times that at 97 per cent, with a straight-line relationship between.

(f) Fabric structure, in order of permeability: (1) plain weave (2) twill and (3) satin. Foil with small orifices was 15 per cent more permeable than single orifices of area equal to the sum of the small orifice area.

19. U.S. Army Air Force, Report of Research and Experiments on the High-Speed Parachute. T-2 Translation 430, July 1946.

A special weave which reduces opening shock and methods of testing are described.

20. Westbrook, F. A., "Permeability of Fabrics to Air and Water Vapor." Textile Manufacturer 73, 451-3 (October 1947).

Test methods and results of starches on fabric permeability to air and water vapor at low velocities (fraction of an inch differential pressure) are presented.

21. Williams, K. A., Jr., The Air Permeability of Woven Fabrics . M.S. Thesis in M.E., Rensselaer Polytechnic Institute, 1949.

Alteration of a commercial apparatus to measure the weight rate of flow of air through woven materials is described. Data taken with this instrument over a range of pressure drops and atmospheric conditions (temperature and humidity) for different types of weaves are presented. The flow is characterized as occurring in a fashion analogous to flow in parallel through a multiplicity of orifices. Results indicate that permeability is maximized by using a square weave with the lowest possible denier yarn and would be minimized by use of the greatest possible denier yarn woven by a system which contained many more threads in the warp than in the weft (or vice versa).

APPENDIX B

Yarn and Fabric Data

TABLE I

ACRILAN YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	2.1	1.8	4.3	---	--	74	3.5	---
At +70° F, 65% RH	1.4	0.7	11.2	1.4	92	30	3.0	---
At 210° F	1.1	---	15.7	1.0	88	8	---	---
At 350° F	0.14	---	17.4	---	--	3	---	---
At room temperature after 24 hours' exposure at:								
-70° F	1.8	1.0	11.5	---	--	--	4.2	---
210° F, 95% RH	1.7	0.8	10.8	---	--	31	3.0	0.0
210° F, 2% RH	1.7	0.8	10.4	---	--	32	3.1	0.0
350° F	1.3	0.9	7.9	---	--	30.0	3.4	---
At room temperature after exposure at 350° F for:								
10 minutes	1.7	---	12.3	---	--	--	---	---
2 hours	1.4	0.8	11.4	1.4	96	27.5	3.4	7.0
6 hours	1.5	0.8	11.0	---	--	27.4	3.2	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 2.1	9, 11
+70° F	1, 1.6	7, 22
210° F	0.25, 0.50, 0.75, 1.1	2, 4, 8, 16
350° F	0.1	4
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 1.7	5.8, 24
24 hours' exposure at 212° F, 95% RH	1, 1.7	6.2, 24.0
2 hours' exposure at 350° F	1, 1.6	6.4, 24.1
6 hours' exposure at 350° F	1, 1.5	7.4, 22.0
24 hours' exposure at 350° F	1, 1.3	3.2, 13.9

[†]Yarn designation: Acrilan--3 deniers, 2-inch staple, 24s/1 cotton count.

TABLE IIA

COTTON YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	2.0	---	5.1	---	--	48	---	---
At +70° F, 65% RH	1.8	---	9.4	1.9	100	20	---	---
At 210° F	1.1	---	6.4	1.0	90	28	---	---
At 350° F	0.9	---	6.7	---	--	17	---	---
At room temperature after 24 hours' exposure at:								
-70° F	1.9	---	9.3	---	--	--	---	---
210° F, 95% RH	1.8	---	9.9	---	--	22	---	1.7
210° F, 2% RH	1.8	---	10.0	---	--	21	---	1.8
350° F	0.5	---	4.3	---	--	15.6	---	---
At room temperature after exposure at 350° F for:								
10 minutes	1.8	---	9.6	---	--	--	---	---
2 hours	1.4	---	8.0	1.4	100	17.7	---	2.5
6 hours	1.1	---	6.9	---	--	18.8	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	1.9	12
+70° F	1, 1.8	7, 19
210° F	0.25, 0.50, 0.75, 1.1	0.4, 1, 2, 7
350° F	0.25, 0.5, 0.75, 0.9	1, 2, 4, 6
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 1.8	5.9, 17.1
24 hours' exposure at 212° F, 95% RH	1, 1.8	5.6, 18.0
2 hours' exposure at 350° F	1, 1.4	5.4, 10.7
6 hours' exposure at 350° F	1, 1.1	5.5, 7.6
24 hours' exposure at 350° F	0.5	1.8

†Yarn designation: Cotton--American Upland, 20s/4 combed, greige.

TABLE IIB

COTTON YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	2.9	---	6.0	---	--	63	---	---
At +70° F, 65% RH	2.1	---	7.7	2.1	97	30	---	---
At 210° F	1.6	---	5.2	1.5	97	41	---	---
At 350° F	1.2	---	6.3	---	--	28	---	---
At room temperature after 24 hours' exposure at:								
-70° F	2.0	---	7.5	---	--	--	---	---
210° F, 95% RH	2.2	---	8.2	---	--	32	---	1.5
210° F, 2% RH	2.1	---	8.3	---	--	32	---	0.8
350° F	1.0	---	4.8	---	--	23.9	---	---
At room temperature after exposure at 350° F for:								
10 minutes	2.0	---	8.0	---	--	--	---	---
2 hours	1.6	---	6.2	1.5	98	28.1	---	2.5
6 hours	1.5	---	6.1	---	--	25.1	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 2.9	6, 17
+70° F	1, 1.9	6, 18
210° F	0.50, 1.0, 1.6	1, 3, 7
350° F	0.5, 1.0, 1.2	1, 4, 6
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 2.1	3.6, 13.7, 16.6
24 hours' exposure at 212° F, 95% RH	1, 2, 2.2	3.6, 14.2, 16.8
2 hours' exposure at 350° F	1, 1.6	3.6, 9.6
6 hours' exposure at 350° F	1, 1.5	3.6, 8.4
24 hours' exposure at 350° F	1.0	3.8

†Yarn designation: Cotton--American Upland, 20s/4 combed, mercerized.

TABLE III

COTTON FABRIC DATA

Fabric Number	Weight (oz/yd²)	Weave	Construction	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Ultimate Elongation (Per Cent) Warp	Ultimate Elongation (Per Cent) Filling	Porosity[a] a	Porosity[a] b	K[b] (%)	Tear Resistance Warp	Tear Resistance Filling	Ref. Number
--	---	4-Harness Sateen 1-3-2-4	---	--	---	--	---	---	---	95	174%	150%	2
--	---	8-End 1/3 45% Twill 4-End Sateen 1-2-4-3	---	--	---	--	---	---	---	94	159%	139%	2
--	---	Granite[c]	---	--	---	--	---	---	---	93	144%	144%	2
--	---	2/1 45% Twill	---	--	---	--	---	---	---	90	133%	122%	2
--	---	Mock Leno	---	--	---	--	---	---	---	83	207%	161%	2
--	---	2/2 Basket 4 Picks	---	--	---	--	---	---	---	82	185%	194%	2
--	---	Zigzag + 2/1 Broken Twill	---	--	---	--	---	---	---	98	152%	139%	2
DTD 562 (Br.)	---	Plain	134 x 125	30	30	--	---	(d)	---	--	--	---	3

(Continued)

TABLE III (Continued)

COTTON FABRIC DATA

Fabric Number	Weight	Weave	Construction	Tensile Strength (Lbs/In)		Ultimate Elongation (Per Cent)		Porosity[a]		K[b]	Tear Resistance		Ref. Number
	(oz/yd^2)			Warp	Filling	Warp	Filling	a	b	(%)	Warp	Filling	
DTD 568 (Br.)	---	Plain	22 x 20	120	120	--	---	(d)	---	--	--	---	3
Cotton 61s (Br.)	---	Basket	103 x 98	42	36	--	---	(d)	---	--	--	---	3
Cotton 1012B (Br.)	---	Basket	58 x 60	90	100	--	---	(d)	---	--	--	---	3
--	2.05	---	---	38	38	--	---	80-140[e]	---	--	2.5[f]	2.5[f]	7
44Z	2.0	---	106 x 104	40	45	--	---	136[e]	---	--	6[f]	4[f]	2
43Z	1.8	---	98 x 93	37	37	--	---	184[e]	---	--	6[f]	5[f]	2
40B	2.5	---	132 x 120	50	50	--	---	114[e]	---	--	13[f]	10[f]	2
40A	2.3	---	120 x 120	48	47	--	---	276[e]	---	--	12[f]	11[f]	2
34B	2.2	---	122 x 104	50	45	--	---	65[e]	---	--	5[f]	4[f]	2
--	---	4-End Plain 8-End 1/3 Pointed Twill	---	--	---	--	---	---	---	99	141%	128%	2

(Continued)

TABLE III (Continued)

COTTON FABRIC DATA

Fabric Number	Weight	Weave	Con-struction	Tensile Strength (Lbs/In)		Ultimate Elongation (Per Cent)		Porosity[a]		K[b]	Tear Resistance		Ref. Number
	(oz/yd²)			Warp	Filling	Warp	Filling	a	b	(%)	Warp	Filling	
02/817a (Br.)	≯1.65	---	108 x 134	<24	≮24	--	---	28[g]	---	--	--	---	17
DTD 633 (Br.)[h]	3.2	---	63 x 65	--	---	--	---	4.625	0.620	--	--	---	5, 25
DTD 596 (Br.)	---	---	---	--	---	--	---	2.895	0.700	--	--	---	5
DTD 583 (Br.)[hi]	2.8	Plain	56 x 56	56	56	--	---	8.635	0.588	--	--	---	3, 5, 25
DTD 524 (Br.)[h]	1.6	---	131 x 138	--	---	--	---	5.94	0.636	--	--	---	5, 25
DTD 418B	>1.5	---	102 x 102	<22	<22	--	---	38-45[g]	(d)	--	--	---	3, 17
DTD 418	---	---	---	--	---	--	---	9.79	0.640	--	--	---	5
Bomb Parachute, Finished	---	---	---	--	62.2	--	29.8	---	---	--	--	---	15
Bomb Parachute, Grey	---	---	---	80.7	77.3	18.2	18.7	---	---	--	--	---	15

(Continued)

TABLE III (Continued)

COTTON FABRIC DATA

Fabric Number	Weight	Weave	Construction	Tensile Strength (Lbs/In)		Ultimate Elongation (Per Cent)		Porosity[a]		K[b]	Tear Resistance		Ref. Number
	(oz/yd^2)			Warp	Filling	Warp	Filling	a	b	(%)	Warp	Filling	
Grade B Airplane, Finished	---	Plain	---	80.5	85.9	27.6	11.7	---	---	--	--	---	15
HH Balloon Fabric, Finished	---	Plain	---	43.8	50.1	9.8	19.4	---	---	--	--	---	15
HH Balloon Fabric, Grey	---	Plain	---	48.1	54.2	12.9	13.9	---	---	--	--	---	15
HH Balloon Fabric	---	Plain	100	44.8	---	11.5	---	---	---	--	--	---	15
HH Balloon Fabric	---	Plain	70	47.4	---	9.3	---	---	---	--	--	---	15
HH Balloon Fabric	---	Plain	50	48.6	---	7.4	---	---	---	--	--	---	15

[a] The experimental data give an empirical curve of the form $Y = aX^b$ at a pressure range of 1/2-17 inches of water, Y = porosity ($ft^3/ft^2/sec$), X = static pressure head (inches of water).

[b] K is the ratio of strength to weight, expressed in per cent.

[c] Granite weave was derived from 2/2 twilled basket and 1/5 twill weaving $\frac{1\ 1\ 2\ 1}{1\ 1\ 2\ 3}$.

(Continued)

TABLE III (Continued)

COTTON FABRIC DATA

[d] The porosity of this fabric increases with increasing tension.

[e] Measured at 1/2 inch of water.

[f] Measured in pounds.

[g] Measured at 10 inches of water.

[h] Weight of 9,000 meters of both warp and filling yarns:

DTD 633 (Br.) = 196 gm.

DTD 583 (Br.) = 195 gm.

DTD 524 (Br.) = 4.5 gm.

[i] Tests for loss of strength after contamination with a mixed microflora obtained from soil (soil-burial test) and exposure to a moist, warm atmosphere (filter-candle test). (See reference 23.)

	Breaking Load for Warp
Soil-Burial Test:	Original--54 lbs/in.
	After 4 days--35 lbs/in.
	After 8 days--19.25 lbs/in.
Filter-Candle Test:	After 6 days--52 lbs/in.
	After 12 days--58.50 lbs/in.

TABLE IVA

DACRON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	8.6	3.0	7.9	5.8	68	152	1.1	---
At +70° F, 65% RH	6.2	1.9	7.8	5.5	89	119	1.7	---
At 210° F	4.5	0.6	10.1	3.8	84	29	2.5	---
At 350° F	2.9	0.4	19.0	---	--	5	5.8	---
At room temperature after 24 hours' exposure at:								
-70° F	6.0	1.6	7.2	---	--	--	1.6	---
210° F, 95% RH	6.3	1.2	13.5	---	--	79	2.1	4.6
210° F, 2% RH	6.4	1.2	13.9	---	--	80	2.1	4.8
350° F	---	---	--	---	--	--	---	---
At room temperature after exposure at 350° F for:								
10 minutes	---	---	--	---	--	--	---	---
2 hours	---	---	--	---	--	--	---	---
6 hours	---	---	--	---	--	--	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 8.6	2, 9, 23, 82
+70° F	1, 2, 4, 6, 6.5	3, 5, 22, 52, 69
210° F	1, 2, 3, 4.2	5, 11, 20, 33
350° F	1, 2, 2.9	6, 14, 56
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 6, 6.4	1.7, 15.2, 39.4, 75.7, 98.0
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 6, 6.3	1.7, 15.5, 40.1, 76.1, 89.7
2 hours' exposure at 350° F	---	---
6 hours' exposure at 350° F	---	---
24 hours' exposure at 350° F	---	---

[†]Yarn designation: Dacron--type 5100, 70 deniers, 34 filaments, 3/4 Z.

TABLE IVB

DACRON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	8.8	2.9	7.6	---	--	186	1.6	---
At +70° F, 65% RH	6.4	1.5	8.9	4.7	73	122	1.5	---
At 210° F	4.2	0.7	11.5	3.6	86	30	2.0	---
At 350° F	2.8	0.3	29.9	---	--	8	3.7	---
At room temperature after 24 hours' exposure at:								
-70° F	6.1	1.6	9.0	---	--	--	1.5	---
210° F, 95% RH	6.3	1.3	15.4	---	--	83	2.2	5.8
210° F, 2% RH	6.2	1.3	15.1	---	--	87	2.2	5.6
350° F	5.5	1.3	34.1	---	--	62.2	3.1	---
At room temperature after exposure at 350° F for:								
10 minutes	6.1	1.3	37.4	4.5	75	--	3.2	---
2 hours	6.4	1.2	35.3	4.8	75	59.5	3.2	18.9
6 hours	5.9	1.2	33.3	---	--	61.2	3.0	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 8.8	2, 10, 27, 109
+70° F	1, 2, 4, 6, 6.7	3, 5, 23, 53, 76
210° F	1, 2, 3, 4.2	7, 15, 23, 43
350° F	1, 2	12, 27
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 6, 6.2	1.5, 18.5, 44.1, 91.5, 108.0
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 6, 6.3	1.5, 17.9, 43.6, 80.8, 110.2
2 hours' exposure at 350° F	1, 2, 3, 4, 6.4	2.4, 33.8, 79.1, 118.7, 249.9
6 hours' exposure at 350° F	1, 2, 3, 4, 5.9	2.4, 31.5, 75.1, 113.2, 224.4
24 hours' exposure at 350° F	1, 2, 3, 4, 5.5	2.1, 29.4, 76.5, 122.3, 226.9

[†]Yarn designation: Dacron--type 5100, 210 deniers, 34 filaments, 1 Z.

TABLE V

DACRON FABRIC DATA*
PHYSICAL AND TEXTILE PROPERTIES

†Fabric Number	Width (Inches)	Weave	Construction		Weight		Elongation (Per Cent)		Tensile Strength	
			Nominal	Finished	(oz/yd^2)	(oz/yd)	Warp	Filling	Warp	Filling
GT-45	32-1/16	Plain	110 x 40	121 x 43.5	1.734	1.545	27.3	37.3	88.2	47.8
GT-46	32	Plain	110 x 50	123 x 53	1.874	1.666	22.6	24	91	56.7
GT-47	32-1/8	Plain	110 x 60	122 x 64	1.971	1.759	23.1	28.8	85.7	61.9
GT-48	32	Plain	110 x 70	122 x 75	2.071	1.840	23.6	25	78.5	70.3
GT-49	32-1/16	Twill	110 x 40	122 x 43	1.740	1.550	33.3	34	101.1	45
GT-50	32	Twill	110 x 50	123 x 54	1.846	1.641	37	30.66	110.1	52.4
GT-51	32	Twill	110 x 60	123 x 66	1.966	1.747	30.66	33.9	96.6	52.4
GT-52	32	Twill	110 x 70	123 x 77	2.100	1.867	34	31.66	106.9	71.8
GT-53	32-1/2	Satin	110 x 40	122 x 44	1.726	1.558	27	29.3	88	36.6
GT-54	32-1/4	Satin	110 x 50	122 x 56	1.817	1.628	31	34	95.4	56
GT-55	32	Satin	110 x 60	123 x 66	1.983	1.762	29.6	36.6	102.8	75.6
GT-56	32	Satin	110 x 70	123 x 78	2.134	1.897	33	35.3	108	83.4

*All data come from reference 19.

†All fabrics have a warp yarn of 77.12/34, 15.9 Z, and a filling yarn of 80.78/34, 1.0 Z.

TABLE VI

DACRON FABRIC DATA

BURSTING STRENGTH

Fabric Number	Test Number 1	2	3	4	5	6	7	8	9	10	Total	Average
GT-47	174	172	166	175	182	170	185	174	169	166	1,733	173.3
GT-48	182	191	189	191	187	184	196	192	197	198	1,907	190.7
GT-52	194	174	191	194	190	189	195	196	176	193	1,892	188.8
GT-56	194	191	197	194	196	189	194	191	194	191	1,931	193.1

TABLE VII

DACRON FABRIC DATA†

AIR PERMEABILITY

Fabric Number	a	b	Range (Inches of Water)	Reference Number
AMC-9	181	0.573	3-50	12
GT-45	492	0.525	3-35	19
GT-46	370	0.491	3-50	19
GT-47	271	0.465	3-50	19
GT-48	180	0.491	3-50	19
GT-49	540	0.521	3-35	19
GT-50	375	0.500	3-50	19
GT-51	225	0.543	3-50	19
GT-52	153	0.494	3-50	19
GT-53	630	0.515	3-30	19
GT-54	391	0.536	3-40	19
GT-55	283	0.524	3-50	19
GT-56	138	0.524	5-55	19

†The data have been found to fit an empirical curve of the form $Y = aX^b$, where Y = air permeability ($ft^3/ft^2/sec$), X = static pressure upstream of cloth (inches of water), and a and b are empirical constants when plotted on log-log paper and applied only to the pressure range indicated.

TABLE VIII

DYNEL YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	---	---	--	---	--	--	---	---
At +70° F, 65% RH	1.4	0.4	27.8	1.4	94	18	3.5	---
At 210° F	0.8	---	46.9	---	--	--	---	---
At 350° F	---	---	--	---	--	--	---	---
At room temperature after 24 hours' exposure at:								
-70° F	---	---	--	---	--	--	---	---
210° F, 95% RH	1.6	0.5	30.2	---	--	11	5.9	1.8
210° F, 2% RH	1.4	0.5	30.5	---	--	11	6.1	1.6
350° F	---	---	--	---	--	--	---	---
At room temperature after exposure at 350° F for:								
10 minutes	---	---	--	---	--	--	---	---
2 hours	---	---	--	---	--	--	---	---
6 hours	---	---	--	---	--	--	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	---	---
+70° F	1, 1.2	28, 36
210° F	---	---
350° F	---	---
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 1.5	26.1, 54.8
24 hours' exposure at 212° F, 95% RH	1, 1.6	25.5, 58.4
2 hours' exposure at 350° F	--- ---	---
6 hours' exposure at 350° F	---	---
24 hours' exposure at 350° F	---	---

[†]Yarn designation: Dynel--spun, 20s/1 cotton count.

TABLE IX

FIBERGLAS YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	---	---	--	---	--	--	---	---
At +70° F, 65% RH	6.0/5.7	---	2.5/3.0	.42/.42	8.0/9.0	210/290	---	---
At 210° F	---	---	--	---	--	--	---	---
At 350° F	---	---	--	---	--	--	---	---
At room temperature after 24 hours' exposure at:								
-70° F	---	---	--	---	--	--	---	---
210° F, 95% RH	---	---	--	---	--	--	---	---
210° F, 2% RH	---	---	--	---	--	--	---	---
350° F	5.3/4.8	---	2.08/2.60	---	--	256/224	---	---
At room temperature after exposure at 350° F for:								
10 minutes	---	---	--	---	--	--	---	---
2 hours	6.8/5.6	---	3.0/3.3	---	--	197/228	---	---
6 hours	5.9/5.1	---	2.2/3.1	---	--	264/213	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	---	---
+70° F	1, 2, 4, 6, 5.8, 6.5	at 450° 1, 2, 7, 14, 17, -- at 225° 1, 3, 8, 15, --, 21
210° F	---	---
350° F	---	---
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	---	---
24 hours' exposure at 212° F, 95% RH	---	---
2 hours' exposure at 350° F	1, 2, 3, 4, at 450° 5.6 at 225° 6.8	at 450° 0.4, 2.0, 4.6, 8.5, 17.7 at 225° 0.5, 1.9, 4.7, 7.9, 23.9
6 hours' exposure at 350° F	1, 2, 3, 4, at 450° 5.1 at 225° 5.9	at 450° 0.4, 1.6, 3.5, 6.4, 11.7 at 225° 0.4, 2.0, 4.6, 8.2, 20.1
24 hours' exposure at 350° F	1, 2, 3, 4, at 450° 4.8 at 225° 5.3	at 450° 0.5, 1.6, 3.8, 7.2, 10.7 at 225° 0.5, 2.1, 5.0, 8.5, 14.9

†Yarn designation: Fiberglas--450/1 and 225/1.

TABLE X

FIBERGLAS FABRIC DATA[†]

PHYSICAL AND TEXTILE PROPERTIES

Style	Warp Yarn	Filling Yarn	Construction	Thickness (Inches)	Weight (oz/yd^2)	Breaking Strength (Lbs/In) Warp	Breaking Strength (Lbs/In) Filling	Weave
106	900-1/0	900-1/0	56 x 56	0.0015	0.85	46	52	Plain
108	900-1/2	900-1/2	60 x 47	0.002	1.43	70	40	Plain
111	225-1/0	225-1/0	24 x 24	0.003	1.33	50	45	Plain
112	450-1/2	450-1/2	40 x 39	0.003	2.09	100	70	Plain
113	450-1/2	900-1/2	60 x 64	0.003	2.46	100	70	Plain
115	225-1/0	225-1/0	48 x 48	0.003	2.54	100	70	Plain
116	450-1/2	450-1/2	60 x 58	0.004	3.16	150	100	Plain
118	450-1/2	450-1/2	90 x 60	0.005	4.06	190	140	Satin
119	450-1/3	450-1/2	54 x 50	0.004	2.80	75	60	Plain
120	450-1/2	450-1/2	60 x 58	0.004	3.16	125	120	Satin
125	450-2/2	450-1/2	36 x 34	0.005	3.93	160	150	Plain

[†]Type EEC.

TABLE XIA

NYLON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	8.0	1.2	11.4	---	--	104	1.2	---
At +70° F, 65% RH	4.7	0.8	18.9	4.5	96	36	2.3	---
At 210° F	3.1	---	13.8	3.2	100	17	---	---
At 350° F	2.3	---	26.0	---	--	11	---	---
At room temperature after 24 hours' exposure at:								
-70° F	4.3	---	18.4	---	--	--	---	---
210° F, 95% RH	4.7	---	24.5	---	--	30	---	5.2
210° F, 2% RH	4.5	---	17.8	---	--	33	---	4.8
350° F	---	---	--	---	--	--	---	---
At room temperature after exposure at 350° F for:								
10 minutes	---	---	--	---	--	--	---	---
2 hours	---	---	--	---	--	--	---	---
6 hours	---	---	--	---	--	--	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 8.0	6, 36, 53, 106
+70° F	1, 2, 4, 6, 4.8	4, 13, 40, --, 124
210° F	---	---
350° F	---	---
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 4.5	6.3, 19.2, 52.4, 91.3
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 4.7	6.2, 18.9, 54.2, 158.9
2 hours' exposure at 350° F	---	---
6 hours' exposure at 350° F	---	---
24 hours' exposure at 350° F	---	---

[†]Yarn designation: Nylon--type 200, 30 deniers, 10 filaments, 1/2 Z, semidull.

TABLE XIB

NYLON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	7.9	1.4	11.3	---	--	89	1.7	---
At +70° F, 65% RH	4.9	1.2	15.1	4.6	93	39	3.2	---
At 210° F	3.4	0.8	13.7	3.4	100	20	3.8	---
At 350° F	2.5	---	15.8	---	--	8	---	---
At room temperature after 24 hours' exposure at:								
-70° F	4.6	---	17.0	---	--	--	---	---
210° F, 95% RH	4.9	---	18.8	---	--	32	---	5.0
210° F, 2% RH	5.0	---	18.7	---	--	34	---	4.7
350° F	1.5	---	6.5	---	--	38.3	---	---
At room temperature after exposure at 350° F for:								
10 minutes	4.7	---	22.2	---	--	--	---	---
2 hours	2.6	---	11.9	2.6	100	32.3	---	7.5
6 hours	2.1	---	9.6	---	--	35.2	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 7.9	5, 19, 52, 97
+70° F	1, 2, 4, 4.9	3, 11, 37, 129
210° F	1, 1.5, 2.0, 3.0, 3.3	1, 6, 17, 40, 46
350° F	0.5, 1.0, 1.5, 2.0, 2.5	2, 6, 12, 20, 44
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 5.0	5.8, 18.1, 46.1, 112.2
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 4.9	5.7, 18.6, 50.1, 108.5
2 hours' exposure at 350° F	1, 2, 2.6	5.5, 20.2, 32.2
6 hours' exposure at 350° F	1, 2, 2.1	5.2, 20.1, 23.5
24 hours' exposure at 350° F	1, 1.5	5.1, 11.6

[†]Yarn designation: Nylon--type 200, 40 deniers, 13 filaments, 1/2 Z, semidull.

TABLE XIC

NYLON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	8.2	1.7	12.3	---	--	107	2.2	---
At +70° F, 65% RH	5.6	0.9	16.6	---	--	39	2.4	---
At 210° F	3.9	0.6	14.6	3.5	90	20	2.8	---
At 350° F	2.6	---	28.8	---	--	17	---	---
At room temperature after 24 hours' exposure at:								
-70° F	5.6	---	18.5	---	--	--	---	---
210° F, 95% RH	6.0	---	23.6	---	--	34	---	5.2
210° F, 2% RH	6.0	---	22.6	---	--	36	---	4.5
350° F	1.3	---	5.1	---	--	46.7	---	---
At room temperature after exposure at 350° F for:								
10 minutes	3.9	---	26.3	5.3	74	--	---	---
2 hours	2.8	---	12.7	1.4	50	43.8	---	8.0
6 hours	2.4	---	10.3	---	--	47.8	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 8.2	7, 33, 61, 107
+70° F	5.6	118
210° F	1, 2, 3, 3.9	6, 19, 31, 48
350° F	1, 2, 2.6	10, 36, 89
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 6.0	5.9, 18.4, 46.4, 153.3
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 6.0	5.8, 18.7, 46.9, 139.3
2 hours' exposure at 350° F	1, 2, 2.8	5.1, 16.7, 42.9
6 hours' exposure at 350° F	1, 2, 2.4	4.8, 19.7, 30.1
24 hours' exposure at 350° F	1, 1.3	3.0, 8.1

[†]Yarn designation: Nylon--type 300, 260 deniers, 17 filaments, 1 Z, bright.

TABLE XID

NYLON YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	9.6	1.5	10.7	6.7	70	128	1.5	---
At +70° F, 65% RH	6.0	1.1	13.9	5.7	96	39	3.0	---
At 210° F	4.6	---	14.4	3.7	80	17	---	---
At 350° F	2.6	---	21.6	---	--	13	---	---
At room temperature after 24 hours' exposure at:								
-70° F	5.8	---	14.2	---	--	--	---	---
210° F, 95% RH	5.9	---	17.9	---	--	33	---	4.0
210° F, 2% RH	5.8	---	16.6	---	--	34	---	3.8
350° F	1.9	---	7.5	---	--	38.9	---	---
At room temperature after exposure at 350° F for:								
10 minutes	---	---	--	---	--	--	---	---
2 hours	2.9	---	12.5	---	--	35.2	---	7.2
6 hours	2.6	---	10.6	---	--	40.9	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 9.6	6, 24, 47, 102
+70° F	1, 2, 4, 6.0	4, 12, 33, 96
210° F	---	---
350° F	---	---
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 5.8	5.5, 17.2, 43.9, 92.7
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 6.0	5.5, 16.7, 42.8, 97.7
2 hours' exposure at 350° F	1, 2, 2.9	5.1, 18.4, 42.2
6 hours' exposure at 350° F	1, 2, 2.6	4.5, 17.0, 31.6
24 hours' exposure at 350° F	1, 1.9	4.5, 16.4

†Yarn designation: Nylon--type 300, 70 deniers, 30 filaments, 3/4 Z, bright.

TABLE XIE

NYLON YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	7.3	1.3	12.1	6.8	93	111	1.1	---
At +70° F, 65% RH	4.2	0.8	15.6	4.3	100	32	1.8	---
At 210° F	3.3	---	22.4	2.9	88	16	---	---
At 350° F	2.0	---	29.8	---	--	11	---	---
At room temperature after 24 hours' exposure at:								
-70° F	4.2	---	23.4	---	--	--	---	---
210° F, 95% RH	4.2	0.4	23.6	---	--	27	1.5	5.2
210° F, 2% RH	4.2	0.4	21.4	---	--	27	1.5	5.0
350° F	1.3	---	7.0	---	--	31.8	---	---
At room temperature after exposure at 350° F for:								
10 minutes	---	---	--	---	--	--	---	---
2 hours	1.8	---	9.6	---	--	28.9	---	8.0
6 hours	1.8	---	9.5	---	--	34.4	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 7.3	8, 32, 63, 104
+70° F	1, 2, 4, 4.4	7, 15, 47, 75
210° F	1.0, 1.5, 2.0, 3.0, 3.3	7, --, 20, 31, 110
350° F	0.5, 1.0, 1.5, 2.0	--, 11, --, 75
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 4.2	7.2, 19.9, 69.2, 114.5
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 4.2	6.6, 20.9, 72.6, 134.3
2 hours' exposure at 350° F	1, 1.8	6.2, 20.9
6 hours' exposure at 350° F	1, 1.8	5.9, 19.5
24 hours' exposure at 350° F	1, 1.3	6.0, 11.0

†Yarn designation: Nylon--type 200, 70 deniers, 34 filaments, 1/2 Z, semidull.

TABLE XIF

NYLON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	8.7	1.7	11.1	---	--	111	1.9	---
At +70° F, 65% RH	7.2	0.8	13.1	5.9	83	50	1.5	---
At 210° F	5.1	0.5	14.2	4.7	92	25	2.0	---
At 350° F	2.9	---	29.4	---	--	12	---	---
At room temperature after 24 hours' exposure at:								
-70° F	6.9	0.5	17.2	---	--	--	1.8	---
210° F, 95% RH	7.1	0.6	18.3	---	--	38	2.0	4.3
210° F, 2% RH	7.0	0.6	18.1	---	--	37	2.0	4.0
350° F	1.8	---	6.6	---	--	61.2	---	---
At room temperature after exposure at 350° F for:								
10 minutes	5.7	---	22.8	5.7	94	--	---	---
2 hours	3.0	---	13.1	---	--	43.8	---	7.4
6 hours	2.7	---	10.7	---	--	46.0	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 8.7	6, 29, 57, 102
+70° F	1, 2, 4, 6, 7.3	3, 11, 31, 54, 98
210° F	1.0, 1.5, 2.0, 3.0, 5.1	6, --, 16, 27, 53
350° F	1.0, 2.0, 2.9	10, 33, 115
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 6, 7	5.8, 17.9, 46.0, 86.2, 119
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 6, 7.1	5.8, 18.3, 45.7, 85.6, 128.1
2 hours' exposure at 350° F	1, 2, 3	5.0, 19.7, 50.1
6 hours' exposure at 350° F	1, 2, 2.7	4.4, 17.9, 35.3
24 hours' exposure at 350° F	1, 1.8	4.4, 14.2

[†]Yarn designation: Nylon--type 300, 210 deniers, 34 filaments, 1 Z, bright.

TABLE XII

NYLON FABRIC DATA*
PHYSICAL AND TEXTILE PROPERTIES

†Fabric Number	Width (Inches)	Weave	Construction		Weight		Elongation (Per Cent)		Tensile Strength	
			Nominal	Finished	(oz/yd²)	(oz/yd)	Warp	Filling	Warp	Filling
GT-1	32-1/2	Plain	70 x 40	77 x 44	1.23	1.11	34.5	30	83	52
GT-2	33	Satin	70 x 80	75.5 x 91	1.82	1.67	38.3	36.7	81	97
GT-3	33	Satin	70 x 70	75.5 x 75	1.50	1.37	38	35.6	74	81
GT-4	33	Satin	70 x 60	76 x 63.5	1.42	1.30	38.3	36.0	78	74
GT-5	33	Satin	70 x 50	76 x 55	1.31	1.20	32	30	71	61
GT-6	33	Satin	70 x 40	77 x 43.5	1.17	1.07	33.3	30.6	65	37
GT-7	31-1/2	Plain	70 x 90	80 x 94	1.75	1.52	36.3	35	88	97
GT-8	32	Plain	70 x 80	78 x 88	1.67	1.48	35.9	35.3	81	81
GT-9	32	Plain	70 x 70	78.5 x 73	1.58	1.40	34	36.6	80	80
GT-10	32	Plain	70 x 60	78.5 x 64.5	1.45	1.29	35	32	82	71
GT-11	32-1/2	Plain	70 x 50	77 x 53.5	1.33	1.20	34.3	34.6	85	61
GT-12	34	Twill	70 x 40	74 x 42	1.12	1.06	36	30	79	53
GT-13	33-1/2	Twill	70 x 50	74.5 x 53	1.29	1.20	34.3	33.3	80	69

(Continued)

TABLE XII (Continued)

NYLON FABRIC DATA*
PHYSICAL AND TEXTILE PROPERTIES

†Fabric Number	Width (Inches)	Weave	Construction Nominal	Construction Finished	Weight (oz/yd^2)	Weight (oz/yd)	Elongation (Per Cent) Warp	Elongation (Per Cent) Filling	Tensile Strength Warp	Tensile Strength Filling
GT-14	33-1/2	Twill	70 x 60	74.5 x 63	1.36	1.27	36.6	32.3	81	80
GT-15	34	Twill	70 x 70	74 x 73	1.46	1.38	32.6	32.3	88	99
GT-16	33-1/2	Twill	70 x 80	75.5 x 82.5	1.57	1.46	34.5	34.5	87	117
GT-17	33-1/2	Twill	70 x 90	75 x 92	1.73	1.61	37.6	37	84	117
GT-18	33-1/4	Plain	125 x 40	137.0 x 41	1.109	1.024	31.6	32.0	72	43
GT-19	32-1/2	Plain	125 x 50	139.25x 52	1.317	1.189	30	31.6	74	54
GT-20	32-1/2	Plain	125 x 60	140.0 x 62	1.423	1.285	30	33.6	74	72
GT-21	32-1/4	Plain	125 x 70	141.5 x 73.25	1.566	1.403	28.3	35	74	83
GT-22	32-1/2	Plain	125 x 80	142.25x 82.25	1.679	1.516	30.3	37.3	73	100
GT-23	33	Satin	125 x 80	139.5 x 84.5	1.651	1.514	33.3	36	83	105
GT-24	33	Satin	125 x 70	138.75x 74.75	1.546	1.418	33.3	34	82	93
GT-25	33	Satin	125 x 60	139 x 64	1.443	1.323	33.3	33.6	87	81
GT-26	33	Satin	125 x 50	138.25 x 53	1.326	1.216	33.3	35	82	67
GT-27	33	Satin	125 x 40	137.5 x 42.5	1.210	1.110	33.3	30	80	48

(Continued)

TABLE XII (Continued)

NYLON FABRIC DATA*
PHYSICAL AND TEXTILE PROPERTIES

†Fabric Number	Width (Inches)	Weave	Construction Nominal	Construction Finished	Weight (oz/yd²)	Weight (oz/yd)	Elongation (Per Cent) Warp	Elongation (Per Cent) Filling	Tensile Strength Warp	Tensile Strength Filling
GT-28	32-1/2	Twill	125 x 40	139.5 x 42	1.231	1.112	34.0	33.3	83	52
GT-29	32-1/2	Twill	125 x 50	140.0 x 52	1.337	1.207	34.0	34	83	66
GT-30	32-1/2	Twill	125 x 60	141.5 x 63.75	1.446	1.306	33.3	36.6	86	81
GT-31	32-1/2	Twill	125 x 70	141.5 x 72.25	1.577	1.424	33.6	35	92	87
GT-32	32-1/2	Twill	125 x 80	143.5 x 83.5	1.697	1.532	33.3	33.3	89	94
GT-57	35-3/8	Plain	125 x 41	128 x 41	1.124	1.109	20.5	19.5	46.8	38.2
GT-58	36-1/4	Plain	125 x 50	125 x 50	1.205	1.213	20.4	19.5	46.0	52.3
GT-59	35-7/8	Plain	125 x 60	126 x 61	1.328	1.323	21.7	22.3	45.4	62.8
GT-60	36-5/8	Plain	125 x 70	126 x 71	1.390	1.415	21.1	24.1	45.7	77.2
GT-61	36-3/8	Plain	125 x 80	126 x 83	1.530	1.546	22.8	21.4	44.4	80.4

*All data come from reference 19.

†Fabrics GT-1 through GT-17 have a warp yarn of 74.73/34, 15.4 Z, and a filling yarn of 80.35/34, 0.86 Z; fabrics GT-18 through GT-32 have a warp yarn of 43.61/13,9.8 Z, and a filling yarn of 80.35/34,0.86 Z. The filling yarn for fabrics GT-1 through GT-32 measured 80.35 denier after finishing and at the time physical tests were made.

Fabrics GT-57 through GT-61 have a warp yarn of 45.28/13, 7.8 Z, and a filling yarn of 73,92/34, 1.3 Z. This filling yarn measured 73.92 denier at the time physical tests were made.

TABLE XIII

NYLON FABRIC DATA*

IDENTIFICATION OF BALLY RIBBON CLOTHS

	Manufacturer's Data							Wright Field Data		
		Thread Count Per Inch		Yarn Size				Thread Count Per Inch		
Fabric Number	Mill Style	Warp	Filling	Warp	Filling	Weave		Warp	Filling	Weight (oz/yd^2)
BR-1	7171	138	110	30/10	30/10	Plain		135	113	1.05
BR-2	7172	138	120	30/10	30/10	Plain		133	122	1.08
BR-3	7173	138	110	30/10	30/10	2/1 Twill		132	113	1.03
BR-4	7174	138	120	30/10	30/10	2/1 Twill		133	125	1.09
BR-5	7175	138	95	30/10	40/13	Plain		134	99	1.12
BR-6	7176	138	105	30/10	40/13	Plain		137	110	1.20
BR-7	7177	138	95	30/10	40/13	2/1 Twill		136	94	1.08
BR-8	7178	138	105	30/10	40/13	2/1 Twill		135	103	1.15
BR-9	7180	120	95	40/13	40/34	Plain		119	85	1.192
BR-10	7181	120	105	40/13	40/34	Plain		118	83	1.175
BR-11	7182	120	95	40/13	40/12	Plain		122	95	1.21
BR-12	7183	120	105	40/13	40/12	Plain		123	105	1.24
BR-13	7184	120	75	40/13	60/20	Plain		123	75	1.30
BR-14	7185	120	85	40/13	60/20	Plain		125	87	1.40
BR-15	7186	120	75	40/13	60/20	2/1 Twill		124	75	1.28
BR-16	7187	120	85	40/13	60/20	2/1 Twill		125	86	1.38
BR-17	7188	100	75	60/20	60/20	Plain		100	75	1.48
BR-18	7189	100	85	60/20	60/20	Plain		102	84	1.55
BR-19	7190	100	75	60/20	60/20	2/1 Twill		101	75	1.49
BR-20	7191	100	85	60/20	60/20	2/1 Twill		101	85	1.51
BR-21	7192	90	68	70/34	70/34	2/1 Twill		88	66	1.50
BR-22	7193	90	78	70/34	70/34	2/1 Twill		88	78	1.60
BR-23	7194	90	68	70/34	70/34	2/2 Twill		89	69	1.55

(Continued)

TABLE XIII (Continued)

NYLON FABRIC DATA*

IDENTIFICATION OF BALLY RIBBON CLOTHS

	Manufacturer's Data						Wright Field Data		
		Thread Count Per Inch		Yarn Size			Thread Count Per Inch		
Fabric Number	Mill Style	Warp	Filling	Warp	Filling	Weave	Warp	Filling	Weight (oz/yd^2)
BR-24	7195	90	78	70/34	70/34	2/2 Twill	91	71	1.68
BR-29	7209	90	68	70/34	70/34	5-Harness Satin	93	70	1.58
BR-30	7210	90	78	70/34	70/34	5-Harness Satin	92	80	1.67
BR-31	7211	90	68	70/34	100/34	2/1 Twill	91	69	1.80
BR-32	7212	90	78	70/34	100/34	2/1 Twill	91	78	1.95
BR-33	7213	90	68	70/34	100/34	2/2 Twill	92	68	1.80
BR-34	7214	90	78	70/34	100/34	2/2 Twill	90	77	1.97
BR-35	7215	90	68	70/34	100/34	5-Harness Satin	92	73	1.78
BR-36	7216	90	78	70/34	100/34	5-Harness Satin	94	80	1.94
BR-37	7217	76	57	100/34	100/34	2/1 Twill	79	57	1.82
BR-38	7218	76	67	100/34	100/34	2/1 Twill	79	66	2.00
BR-39	7219	76	57	100/34	100/34	2/2 Twill	81	57	1.83
BR-40	7220	76	67	100/34	100/34	2/2 Twill	79	69	2.02
BR-45	7225	76	57	100/34	100/34	5-Harness Satin	82	57	1.87
BR-46	7226	76	67	100/34	100/34	5-Harness Satin	81	67	2.00
BR-49	7229	180	80	150/68	150/68	4 x 4 Basket	188	80	5.81
BR-50	7230	180	90	150/68	150/68	4 x 4 Basket	188	92	6.11

(Continued)

TABLE XIII (Continued)

NYLON FABRIC DATA*

IDENTIFICATION OF BALLY RIBBON CLOTHS

		Manufacturer's Data					Wright Field Data		
		Thread Count Per Inch		Yarn Size			Thread Count Per Inch		
Fabric Number	Mill Style	Warp	Filling	Warp	Filling	Weave	Warp	Filling	Weight (oz/yd^2)
BR-51	7231	180	80	150/68	150/68	5-Harness Satin	183	77	5.58
BR-52	7232	180	90	150/68	150/68	5-Harness Satin	181	76	5.52
BR-53	7233	180	80	150/68	210/34	5-Harness Satin	186	76	6.34
BR-54	7234	180	90	150/68	210/34	5-Harness Satin	185	78	6.34
BR-55	7235	180	80	150/68	260/17	5-Harness Satin	181	79	7.00
BR-56	7236	180	90	150/68	260/17	5-Harness Satin	185	79	7.05
BR-57	7237	120	80	210/34	210/34	2 x 2 Basket	120	76	5.75
BR-58	7238	120	90	210/34	210/34	2 x 2 Basket	120	78	5.76
BR-59	7239	120	80	210/34	210/34	5-Harness Satin	122	68	5.60
BR-60	7240	120	90	210/34	210/34	5-Harness Satin	120	70	5.64
BR-61	7241	120	70	210/34	260/17	2 x 2 Basket	120	70	6.15
BR-62	7242	120	80	210/34	260/17	2 x 2 Basket	120	80	6.64
BR-63	7243	120	70	210/32	260/17	5-Harness Satin	123	69	6.01
BR-64	7244	120	80	210/32	260/17	5-Harness Satin	122	72	6.11

(Continued)

TABLE XIII (Continued)

NYLON FABRIC DATA*

IDENTIFICATION OF BALLY RIBBON CLOTHS

		Manufacturer's Data					Wright Field Data		
		Thread Count Per Inch		Yarn Size			Thread Count Per Inch		
Fabric Number	Mill Style	Warp	Filling	Warp	Filling	Weave	Warp	Filling	Weight (oz/yd^2)
BR-65	7245	97	60	260/17	260/17	2 x 2 Basket	100	60	5.78
BR-66	7246	97	70	260/17	260/17	2 x 2 Basket	102	70	6.07
BR-67	7247	97	60	260/17	260/17	4 x 4 Basket	100	60	5.61
BR-68	7248	97	70	260/17	260/17	4 x 4 Basket	99	71	6.03
BR-69	7249	97	60	260/17	260/17	5-Harness Satin	103	60	5.88
BR-70	7250	97	70	260/17	260/17	5-Harness Satin	103	65	6.13

*All data come from reference 12.

Notes: Fabrics BR-1 through BR-48--The yarns shall have approximately 1.0 turns per inch twist.

Fabrics BR-49 through 70--The yarns shall be twisted to produce yarns suitable for clothing fabrics.

TABLE XIV

NYLON FABRIC DATA

BURSTING STRENGTH

Fabric Number	Test Number 1	2	3	4	5	6	7	8	9	10	Total	Average
GT-18	143	133	135	146	139	133	136	127	144	141	1,377	137.7
GT-19	167	165	130	160	135	119	167	145	140	124	1,452	145.2
GT-20	146	156	152	144	130	141	141	147	179	150	1,486	148.6
GT-21	181	193	185	161	171	153	169	157	160	185	1,715	171.5
GT-22	194	190	187	187	189	194	193	194	192	195	1,915	191.5
GT-23	157	199	185	181	149	156	153	177	167	171	1,695	169.5
GT-24	157	158	150	153	157	186	146	161	150	178	1,596	159.6
GT-25	150	147	165	152	158	166	145	172	145	148	1,548	154.8
GT-26	159	159	161	156	161	162	151	153	153	154	1,569	156.9
GT-28	150	151	147	152	149	139	126	120	124	142	1,400	140.0
GT-29	156	156	160	156	151	165	152	151	154	151	1,552	155.2
GT-30	160	162	163	172	168	162	171	170	167	170	1,665	166.5
GT-31	187	171	177	174	178	178	178	180	179	176	1,778	177.8
GT-32	171	172	175	172	169	176	182	175	185	177	1,754	175.4
BR-1	92	92	79	74	80	86	70	70	70	73	786	78.6
BR-2	96	96	76	95	99	101	103	100	99	96	981	98.1
BR-3	137	90	76	110	86	100	94	99	80	106	998	99.8

(Continued)

TABLE XIV (Continued)

NYLON FABRIC DATA

BURSTING STRENGTH

Fabric Number	Test Number 1	2	3	4	5	6	7	8	9	10	Total	Average
BR-4	104	105	124	104	117	105	92	96	102	100	1,049	104.9
BR-5	87	78	85	80	81	70	83	79	82	77	802	80.2
BR-6	135	86	103	113	126	88	93	85	109	92	1,030	103.0
BR-7	91	117	93	84	88	86	98	86	81	86	910	91.0
BR-8	114	112	115	112	109	111	116	120	101	125	1,035	103.5
BR-9	133	136	139	137	140	135	131	131	134	137	1,353	135.3
BR-10	130	129	124	136	135	139	128	137	132	134	1,324	132.4
BR-11	85	92	82	103	85	82	83	97	94	85	888	88.8
BR-12	103	130	87	96	96	96	94	124	100	102	1,028	102.8
BR-13	112	101	110	125	120	122	112	109	114	92	1,117	111.7
BR-14	142	146	144	116	130	141	139	137	140	146	1,381	138.1
BR-15	131	131	122	127	136	127	126	123	129	132	1,284	128.4
BR-16	140	143	134	157	160	135	133	134	136	143	1,415	141.5
BR-17	154	156	154	157	160	153	157	164	157	166	1,578	157.8
BR-18	178	173	176	177	182	186	183	189	181	180	1,805	180.5
BR-19	166	164	166	170	147	166	180	157	155	180	1,651	165.1
BR-20	183	186	183	170	176	180	156	182	177	190	1,783	178.3

TABLE XV

NYLON FABRIC DATA

EFFECT ON AIR PERMEABILITY OF DIFFERENT SHROUD LINES
AND LAUNCHING SPEEDS FOR NYLON PARACHUTES

Canopy Diameter (Feet)	Launching Speed (MPH)	Air Permeability ($Ft^3/Ft^2/Min$) Using Suspension Line Group				
		I	II	III	IV	V
24	Start	99.90	96.50	97.10	99.80	95.80
	100	99.90	96.50	97.10	99.90	95.80
	150	100.30	97.30	96.90	100.20	95.60
	200	90.30	102.10	110.90	101.80	98.60
30	Start	93.75	91.07	89.37	87.52	92.73
	100	93.75	91.07	89.37	87.52	92.73
	150	93.90	97.43	90.15	87.52	93.70
	200	86.30	87.50	87.25	86.95	91.80

TABLE XVI

NYLON FABRIC DATA†

AIR PERMEABILITY

Fabric Number	a	b	Test Range (Inches of Water)	Reference Number
DTD-556	5.08	0.556	1/2-17	5
GT-1	885	0.530	1/2-16	19
GT-2	658	0.585	3-55	19
GT-3	260	0.555	4-50	19
GT-4	327	0.565	2-45	19
GT-5	525	0.563	2-30	19
GT-6	834	0.536	1-16	19
GT-7	64	0.536	2-54	19
GT-8	87.5	0.596	5-50	19
GT-9	136	0.515	6-50	19
GT-10	413	0.514	2-46	19
GT-11	680	0.523	1-24	19
GT-12	904	0.528	1-16	19
GT-13	635	0.522	1-30	19
GT-14	423	0.520	1-45	19
GT-15	320	0.520	2-50	19
GT-16	230	0.554	3-55	19
GT-17	260	0.512	1-45	19
GT-18	444	0.544	1-35	19
GT-19	286	0.551	2-50	19
GT-20	206	0.558	1-55	19
GT-21	133	0.577	3-55	19
GT-22	112	0.584	3-54	19
GT-23	68	0.625	3-55	19
GT-24	105	0.611	5-55	19

(Continued)

TABLE XVI (Continued)

NYLON FABRIC DATA†

AIR PERMEABILITY

Fabric Number	a	b	Test Range (Inches of Water)	Reference Number
GT-25	165	0.631	3-55	19
GT-26	341	0.523	1-45	19
GT-27	551	0.531	1-30	19
GT-28	456	0.562	2-34	19
GT-29	304	0.543	3-50	19
GT-30	171	0.585	3-55	19
GT-31	134	0.591	4-50	19
GT-32	81.8	0.607	5-55	19
GT-57	885	0.505	1-18	19
GT-58	665	0.495	3-30	19
GT-59	500	0.502	3-35	19
GT-60	400	0.489	3-45	19
GT-61	209	0.578	3-50	19
AMC-1	165	0.629	4-50	12
AMC-2	163	0.627	4-50	12
AMC-3	228	0.552	3-50	12
AMC-4	147	0.589	3-50	12
AMC-5	170	0.590	3-50	12
AMC-6	360	0.540	1-50	12
AMC-7	176	0.605	3-50	12
AMC-8	384	0.571	1-50	12
BR-1	533	0.549	1-30	12
BR-2	533	0.514	1-30	12
BR-3	622	0.550	1-25	12

(Continued)

TABLE XVI (Continued)

NYLON FABRIC DATA†

AIR PERMEABILITY

Fabric Number	a	b	Test Range (Inches of Water)	Reference Number
BR-4	527	0.555	1-30	12
BR-5	583	0.534	1-30	12
BR-6	521	0.519	1-30	12
BR-7	682	0.521	1-30	12
BR-8	595	0.531	1-30	12
BR-9	589	0.521	1-30	12
BR-10	634	0.529	1-30	12
BR-11	553	0.548	1-30	12
BR-12	493	0.530	1-40	12
BR-13	371	0.506	1-40	12
BR-14	320	0.438	1-50	12
BR-15	331	0.548	1-50	12
BR-16	235	0.558	1-55	12
BR-17	392	0.497	1-50	12, 19
BR-18	279	0.467	1-55	12, 19
BR-19	372	0.497	1-50	12
BR-20	276	0.447	1-50	12
BR-21	766	0.510	1-25	12, 19
BR-22	634	0.508	1-30	12, 19
BR-23	800	0.500	1-25	12
BR-24	638	0.516	1-27	12, 19
BR-29	863	0.540	1-18	12, 19
BR-30	751	0.520	1-22	12
BR-31	264	0.475	1-58	12
BR-32	156	0.472	1-60	12

(Continued)

TABLE XVI (Continued)

NYLON FABRIC DATA[†]

AIR PERMEABILITY

Fabric Number	a	b	Test Range (Inches of Water)	Reference Number
BR-33	234	0.472	1-60	12
BR-34	126	0.541	3-60	12, 19
BR-35	216	0.443	1-55	12, 19
BR-36	120	0.534	2-60	12
BR-37	444	0.474	1-42	12
BR-38	278	0.498	1-55	12
BR-39	324	0.519	2-50	12
BR-40	211	0.478	1-55	12
BR-45	372	0.480	1-50	12
BR-46	233	0.495	1-60	12
BR-49	7.1	1.74	15-50	12
BR-50	5.4	1.77	15-60	12
BR-51	14.8	0.726	5-50	12
BR-52	14.0	0.739	5-50	12
BR-53	37.5	0.646	5-50	12
BR-54	48.5	0.607	5-50	12
BR-55	66.3	0.593	5-50	12
BR-56	62.0	0.586	5-50	12
BR-57	6.1	0.769	15-50	12, 19
BR-58	5.6	0.757	20-54	12
BR-59	19.7	0.577	5-50	12
BR-60	19	0.740	10-50	12
BR-61	9.6	0.736	10-50	12
BR-62	7.6	0.753	15-50	12
BR-63	28.2	0.647	5-45	12

(Continued)

TABLE XVI (Continued)

NYLON FABRIC DATA†

AIR PERMEABILITY

Fabric Number	a	b	Test Range (Inches of Water)	Reference Number
BR-64	22.0	0.679	5-45	12
BR-65	21.4	0.674	5-45	12, 19
BR-66	10.5	0.888	7-50	12
BR-67	80	0.585	5-55	12
BR-68	82.5	0.541	5-55	12
BR-69	59.5	0.634	5-55	12, 19
BR-70	43	0.678	5-55	12, 19

†The data have been found to fit an empirical curve of the form $Y = aX^b$, where Y = air permeability ($ft^3/ft^2/sec$), X = static pressure upstream of cloth (inches of water), and a and b are empirical constants when plotted on log-log paper and applied only to the pressure range indicated.

TABLE XVIIA

ORLON YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	6.4	3.9	13.6	---	--	130	3.8	---
At +70° F, 65% RH	4.0	1.2	14.4	3.1	77	74	2.1	---
At 210° F	2.5	---	20.2	2.2	89	7	---	---
At 350° F	0.3	---	28.3	---	--	3	---	---
At room temperature after 24 hours' exposure at:								
-70° F	4.1	1.2	15.3	---	--	--	2.1	---
210° F, 95% RH	4.1	1.1	15.7	---	--	73	2.0	0.8
210° F, 2% RH	4.2	1.1	15.4	---	--	74	2.0	0.8
350° F	---	---	--	---	--	--	---	---
At room temperature after exposure at 350° F for:								
10 minutes	4.1	---	18.0	---	--	--	---	---
2 hours	---	---	--	2.3	55	--	---	---
6 hours	---	---	--	---	--	--	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 6.4	4, 34, 101, 116
+70° F	1, 2, 4, 4.1	2, 24, 70, 72
210° F	1, 2, 2.5	10, 31, 48
350° F	---	---
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 4.2	1.9, 20.7, 71.1, 79.4
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 4.1	1.7, 20.7, 74.7, 78.6
2 hours' exposure at 350° F	---	---
6 hours' exposure at 350° F	---	---
24 hours' exposure at 350° F	---	---

†Yarn designation: Orlon--100 deniers, 40 filaments, 0.3 Z, bright.

TABLE XVIIB

ORLON YARN DATA†

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	5.5	3.5	11.4	---	--	143	3.1	---
At +70° F, 65% RH	3.9	1.1	15.3	3.1	81	72	2.2	---
At 210° F	2.5	---	19.1	2.2	89	8	---	---
At 350° F	0.3	---	16.7	---	--	4	---	---
At room temperature after 24 hours' exposure at:								
-70° F	3.9	1.2	14.6	---	--	--	2.0	---
210° F, 95% RH	4.0	1.1	16.3	---	--	73	2.0	2.5
210° F, 2% RH	4.2	1.1	16.5	---	--	78	1.9	2.5
350° F	3.1	1.2	13.3	---	--	51.3	3.0	---
At room temperature after exposure at 350° F for:								
10 minutes	---	1.2	--	4.0	89	--	2.2	7
2 hours	4.4	1.2	17.5	---	--	50.2	2.9	8.4
6 hours	4.3	1.2	17.3	---	--	53.3	2.8	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 5.5	4, 31, 67
+70° F	1, 2, 4, 4.2	2, 23, 71, 76
210° F	1.0, 2.0, 2.5	11, 30, 41
350° F	---	---
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 4.2	1.2, 22.0, 73.4, 82.3
24 hours' exposure at 212° F, 95% RH	1, 2, 4	1.7, 21.9, 76.3
2 hours' exposure at 350° F	1, 2, 3, 4, 4.4	2.7, 20.3, 44.1, 73.9, 91.2
6 hours' exposure at 350° F	1, 2, 3, 4, 4.3	2.1, 20.5, 43.8, 75, 89.3
24 hours' exposure at 350° F	1, 2, 3, 3.1	2.4, 19.9, 46.9, 54.3

†Yarn designation: Orlon--200 deniers, 80 filaments, 0.3 Z, bright.

TABLE XVIII

ORLON FABRIC DATA*
PHYSICAL AND TEXTILE PROPERTIES

†Fabric Number	Width (Inches)	Weave	Construction		Weight		Elongation (Per Cent)		Tensile Strength	
			Nominal	Finished	(oz/yd^2)	(oz/yd)	Warp	Filling	Warp	Filling
GT-33	34-3/4	Plain	100 x 40	102 x 41	1.442	1.392	11.6	14	51.9	31.3
GT-34	34-5/8	Plain	100 x 50	102 x 51	1.554	1.494	12.3	13.3	46.5	36
GT-35	34-1/4	Plain	104 x 60	104 x 61	1.668	1.587	11.6	13.6	53.4	40.2
GT-36	34-1/4	Plain	100 x 70	103 x 70	1.751	1.666	12.6	16	49.2	36.4
GT-37	34-7/8	Twill	100 x 40	102 x 40	1.440	1.395	12	13.6	48.3	25.4
GT-38	35	Twill	100 x 50	102 x 51	1.525	1.482	12	15.6	53.1	34.8
GT-39	34-7/8	Twill	100 x 60	103 x 61	1.611	1.560	12	15	50.2	38.5
GT-40	34-3/4	Twill	100 x 70	103 x 70	1.748	1.687	12.3	16.3	52.6	41.5
GT-41	35	Satin	100 x 40	102 x 40.5	1.397	1.358	11.6	14.3	46	22.2
GT-42	34-7/8	Satin	100 x 50	100 x 52	1.548	1.499	11.6	15	50.4	30.2
GT-43	35-1/8	Satin	100 x 60	100 x 60	1.637	1.597	12	13.6	56.2	39.3
GT-44	35	Satin	100 x 70	102 x 70	1.751	1.702	12	15	52.1	43.8

*All data come from reference 19.

†All fabrics have a warp yarn of 79.55/30, 7.6 Z, and a filling yarn of 80.35/30, 0.8 Z.

TABLE XIX

ORLON FABRIC DATA

BURSTING STRENGTH

Fabric Number	Test Number 1	2	3	4	5	6	7	8	9	10	Total	Average
GT-35	127	127	117	117	126	117	119	123	122	115	1,210	121.0
GT-36	129	154	129	132	134	143	148	124	135	145	1,373	137.3
GT-40	113	121	131	113	121	130	106	113	103	112	1,163	116.3
GT-43	111	112	125	112	126	122	124	126	128	114	1,200	120.0
GT-44	108	113	140	145	141	154	144	141	118	119	1,323	132.3

TABLE XX

ORLON FABRIC DATA†

AIR PERMEABILITY

Fabric Number	a	b	Range (Inches of Water)	Reference Number
AMC-10	267	0.515	3-50	12
GT-33	532	0.510	2-32	19
GT-34	342	0.488	1-50	19
GT-35	170	0.538	3-55	19
GT-36	91.8	0.546	5-55	19
GT-37	422	0.497	1-40	19
GT-38	229	0.564	3-50	19
GT-39	138	0.568	3-55	19
GT-40	91.8	0.598	5-55	19
GT-41	532	0.510	2-30	19
GT-42	285	0.541	5-55	19
GT-43	190	0.547	5-55	19
GT-44	152	0.547	5-55	19

†The data have been found to fit an empirical curve of the form $Y = aX^b$, where Y = air permeability ($ft^3/ft^2/sec$), X = static pressure upstream of cloth (inches of water), and a and b are empirical constants when plotted on log-log paper and applied only to the pressure range indicated.

TABLE XXIA

RAYON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	7.9	2.3	5.2	---	--	314	1.0	---
At +70° F, 65% RH	6.3	1.6	5.8	3.2	51	227	1.0	---
At 210° F	4.2	1.9	3.6	3.1	74	225	1.0	---
At 350° F	2.6	1.4	3.0	---	--	173	0.9	---
At room temperature after 24 hours' exposure at:								
-70° F	5.8	1.6	5.9	---	--	--	1.0	---
210° F, 95% RH	5.4	1.4	5.2	---	--	214	0.9	0.0
210° F, 2% RH	5.8	1.5	5.6	---	--	225	0.9	0.0
350° F	1.1	---	1.21	---	--	101	---	---
At room temperature after exposure at 350° F for:								
10 minutes	4.2	1.6	4.2	---	--	--	1.0	---
2 hours	1.5	1.2	1.88	1.3	87	113	1.2	0.0
6 hours	1.3	---	1.37	---	--	108	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 6, 7.9	1, 9, 23, 47
+70° F	2, 4, 6, 6.4	4, 19, 36, 44
210° F	2, 3, 4.2	3, 9, 20
350° F	2, 2.6	5, 10
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 4, 5.8	0.5, 4.4, 18.0, 35.0
24 hours' exposure at 212° F, 95% RH	1, 2, 4, 5.4	0.5, 4.7, 18.9, 32.6
2 hours' exposure at 350° F	1, 1.5	1.5, 3.8
6 hours' exposure at 350° F	1, 1.3	0.9, 2.0
24 hours' exposure at 350° F	1, 1.1	1.0, 1.4

[†]Yarn designation: Fortisan (saponified acetate rayon)--270 deniers, 360 filaments, LTD.

TABLE XXIB

RAYON YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	3.9	1.5	12.4	---	--	132	2.0	---
At +70° F, 65% RH	2.4	0.8	20.0	2.3	97	73	1.9	---
At 210° F	2.3	1.2	8.1	2.3	100	90	2.0	---
At 350° F	1.9	0.6	14.4	---	--	40	1.6	---
At room temperature after 24 hours' exposure at:								
-70° F	2.4	0.8	18.6	---	--	--	1.8	---
210° F, 95% RH	2.4	0.7	20.0	---	--	57	1.8	0.2
210° F, 2% RH	2.4	0.7	19.9	---	--	57	1.8	1.0
350° F	1.0	0.75	8.6	---	--	76.2	1.7	---
At room temperature after exposure at 350° F for:								
10 minutes	2.3	---	18.0	---	--	--	---	---
2 hours	1.8	0.75	14.3	1.7	90	77.6	1.7	0.8
6 hours	1.5	0.75	12.4	---	--	78.4	1.7	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 3.9	12, 71
+70° F	1, 2, 2.5	9, 42, 72
210° F	1, 1.5, 2.0, 2.3	2, 7, 19, 27
350° F	0.5, 1.0, 1.5, 1.9	1, 9, 21, 38
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	1, 2, 2.4	10.1, 39.8, 63.7
24 hours' exposure at 212° F, 95% RH	1, 2, 2.4	9.5, 39.4, 64.6
2 hours' exposure at 350° F	1, 1.8	10.2, 35.9
6 hours' exposure at 350° F	1, 1.5	10.6, 25.8
24 hours' exposure at 350° F	1.0	14.0

[†]Yarn designationTenasco (high-tenacity viscose rayon)--300 deniers, 120 filaments.

TABLE XXII

RAYON FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Fiber	Yarn Size	Weave	Weight (oz/yd^2)	Con-struction	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Ultimate Elongation (Per Cent) Warp	Ultimate Elongation (Per Cent) Filling	Air Permeability	Ref. Number
V 7280 (Br.)	Tenasco	--	Plain	--	131 x 115	26	27	---	---	Decrease[a]	3
V 7281 (Br.)	Tenasco	--	Mock Leno	--	120 x 114	36	35	---	---	Decrease[a]	3
V 7584 (Br.)	Tenasco	--	Mock Leno	--	50/2 x 54	140	170	---	---	Decrease[a]	3
DTD 526 (Br.)	Celanese	--	Plain	--	200 x 100	50	40	---	---	None[a]	3
V 7481 (Br.)	Viscose	--	Mock Leno	--	118 x 112	27	25	---	---	Decrease[a]	3
BW 6803 (Br.)	Viscose	--	Plain	--	118 x 110	27	26	---	---	Decrease[a]	3
Canopy Fabric[b]	Fortisan	--	---	--	---	76	68	7.6	7.6	--	13
V 7721 (Br.)	Viscose	207 gm[c]	---	2.9	57 x 51	--	---	---	---	22.4 ft/sec[d]	25
H 1276	Celanese	30 gm[c]	---	0.8	103 x 100	--	---	---	---	25.8 ft/sec[d]	25

(Continued)

TABLE XXII (Continued)

RAYON FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Fiber	Yarn Size	Weave	Weight	Construction	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Ultimate Elongation (Per Cent) Warp	Ultimate Elongation (Per Cent) Filling	Air Permeability	Ref. Number
				(oz/yd^2)							
AAF-16123	High-Tenacity	--	---	8	45 x 45	--	---	18	18	--	1
AAF-16126	Viscose	300-275s	---	4.25	---	(e)	(e)	≥15	≥15	150 ± 30 $ft^3/ft^2/min$	1
AN-CCC-C-491	Fortisan	--	2/1 Twill	1.6	---	--	---	>5	>5	80-160 $ft^3/ft^2/min$	1
AAF-16144	Acetate	--	---	4.5	---	--	---	≥45	≥45	120 ± 40 $ft^3/ft^2/min$	1
AAF-16138	Fortisan	30 den	---	0.9	110 x 110	--	---	$\bar{>}$6	$\bar{>}$6	240 ± 60 $ft^3/ft^2/min$	1
AAF-16141	--	--	Rip Stop	2.5	80 x 70	--	---	$\bar{>}$15	$\bar{>}$15	100-200 $ft^3/ft^2/min$	1
AXS-727	High-Tenacity	50/24, 6 TPI	Plain	1.35	86-100 x 86-100	--	---	---	---	400-500 $ft^3/ft^2/min$	1
AXS-701	Viscose	275-300 den, 3 TPI	Plain	4	47-52 x 42-52	--	---	---	---	150 ± 30 $ft^3/ft^2/min$	1

(Continued)

TABLE XXII (Continued)

RAYON FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Fiber	Yarn Size	Weave	Weight	Con-struction	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Ultimate Elongation (Per Cent) Warp	Ultimate Elongation (Per Cent) Filling	Air Permeability	Ref. Number
				(oz/yd^2)							
Para-chute Fabric	Vixcose	--	1/1	1.8	---	50	50	---	---	80-140 $ft^3/ft^2/min$[f]	7
V 7695 (Br.)	Viscose	--	---	--	---	--	---	---	---	a = 5.94[g] b = 0.560	5
DTD 526	Celanese	--	---	--	---	--	---	---	---	a = 3.96[g] b = 0.544	5

[a] Effect of tension on porosity.

[b] This fabric had a Mullen bursting strength of 171 lbs/in^2 and an impact strength of 206 lbs/in^2.

[c] Weight of 9,000 meters.

[d] Measured at 10 inches of water.

[e] Measured as 2.75 gm/den.

[f] Measured at 1/2 inch of water.

[g] Data fit an empirical equation of the form $Y = aX^b$, measured at a pressure range of 1/2-17 inches of water.

TABLE XXIII

SILK YARN DATA[†]

Test Conditions	Breaking Strength (gm/den)	Tenacity (Yield) (gm/den)	Ultimate Elongation (Per Cent)	Loop Strength (gm/den)	Loop Efficiency (Per Cent)	Initial Modulus (gm/den)	Yield Point (Elongation %)	Shrinkage (Per Cent)
At -70° F	4.4	3.0	8.0	---	--	126	3.2	---
At +70° F, 65% RH	3.5	1.6	18.7	2.6	74	68	2.8	---
At 210° F	2.8	1.5	9.2	2.1	75	68	3.0	---
At 350° F	2.2	1.2	10.2	---	--	54	2.8	---
At room temperature after 24 hours' exposure at:								
-70° F	3.2	1.5	18.1	---	--	--	2.5	---
210° F, 95% RH	---	---	--	---	--	--	---	---
210° F, 2% RH	3.1	1.3	14.7	---	--	--	2.1	---
350° F	0.5	---	0.8	---	--	--	---	---
At room temperature after exposure at 350° F for:								
10 minutes	2.7	1.5	13.4	---	--	--	2.5	---
2 hours	2.2	1.5	8.3	1.6	72	--	2.5	---
6 hours	---	---	--	---	--	--	---	---

	Stress	ΔE
Energy absorbed to several stress levels at:		
-70° F	2, 4, 4.4	4, 37, 51
+70° F	1, 2, 3.5	2, 16, 116
210° F	1, 1.5, 2.0, 2.8	2, 5, 11, 39
350° F	1.0, 1.5, 2.0, 2.2	3, 10, 26, 32
Energy absorbed to several stress levels after:		
24 hours' exposure at 212° F, 2% RH	3.1	72.0
24 hours' exposure at 212° F, 95% RH	---	---
2 hours' exposure at 350° F	---	---
6 hours' exposure at 350° F	---	---
24 hours' exposure at 350° F	---	---

[†]Yarn designation: Japan Gum Silk--five threads, 20/22.

TABLE XXIV

SILK YARN DATA*

TENSILE STRENGTH AND ULTIMATE ELONGATION OF SILK YARNS
AT 21° C AND AT VARIOUS RELATIVE HUMIDITIES

Number of Threads	Twist (TPI)	Denier per Thread (Dry)	Denier per Thread (65% RH)	Breaking Strength (gm) at 33% RH	43% RH	50% RH	55% RH	65% RH	76% RH	86% RH	Ultimate Elongation (Per Cent) at 33% RH	43% RH	50% RH	55% RH	65% RH	76% RH	86% RH
9	36	15.5	16.8	482	476	478	480	477	453	428	20.8	21.0	22.4	23.2	24.0	25.8	29.1
1	--	13	15	51	45	49	47	50	45	401	17.8	18.5	19.4	20.5	23.1	22.4	25.7
9	15	14.2	15.4	510	519	508	500	510	484	459	18.2	19.0	19.4	19.5	20.6	22.8	25.1
9	6	13.9	15.1	498	519	518	507	474	483	427	16.1	17.4	18.3	18.8	20.1	22.9	24.6
7	36	15.6	16.9	362	373	385	374	364	345	306	19.5	20.8	21.1	21.0	22.3	24.8	25.5
7	15	14.5	15.7	407	382	380	400	413	388	348	17.9	18.0	18.8	19.7	21.9	22.9	24.7
7	10	13.8	15.0	384	378	365	360	463	333	315	14.9	16.1	16.4	17.3	19.0	20.4	22.5
5	36	15.0	16.2	265	276	278	265	273	238	208	17.3	18.6	18.5	18.8	20.7	18.5	20.2
5	20	14.7	15.9	263	261	258	267	270	261	244	16.2	17.8	18.2	18.6	20.0	21.7	24.0
5	15	14.1	15.3	287	289	293	284	276	276	243	16.8	17.5	18.6	19.5	20.0	22.7	24.5

(Continued)

TABLE XXIV (Continued)

SILK YARN DATA*

TENSILE STRENGTH AND ULTIMATE ELONGATION OF SILK YARNS
AT 21° C AND AT VARIOUS RELATIVE HUMIDITIES

Number of Threads	Twist (TPI)	Denier per Thread (Dry)	Denier per Thread (65% RH)	Breaking Strength (gm) at 33% RH	43% RH	50% RH	55% RH	65% RH	76% RH	86% RH	Ultimate Elongation (Per Cent) at 33% RH	43% RH	50% RH	55% RH	65% RH	76% RH	86% RH
5	6	13.5	14.7	270	263	273	263	251	252	246	16.3	17.9	18.4	18.7	20.6	21.7	25.2
4	36	14.5	15.8	204	213	221	210	196	199	170	17.2	18.5	19.5	19.0	19.5	21.8	23.0
4	18	14.4	15.7	220	230	230	217	217	203	183	15.8	17.1	18.3	18.0	19.5	20.3	21.7
4	10	14.0	15.2	200	198	206	210	197	197	182	15.1	15.9	16.8	17.3	18.4	20.7	22.8
3	30	14.8	16.1	169	178	178	173	164	170	148	15.7	16.1	17.4	17.7	18.8	20.7	22.6
3	30	13.7	14.9	142	157	156	155	160	150	128	15.6	16.5	16.4	17.5	19.8	20.6	22.0
3	20	13.7	14.9	161	160	153	156	156	149	133	14.1	15.1	15.8	16.1	18.0	19.7	20.7
2	25	14.1	15.4	101	113	107	104	102	101	85	13.2	15.4	15.0	15.5	17.0	18.9	20.1
2	36	14.3	15.7	107	104	117	116	112	99	91	15.9	15.1	16.7	17.4	18.5	19.4	23.0

*All data come from reference 27.

TABLE XXV

SILK FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Weave	Yarn Size (Denier)	Con-struction	Weight (oz/yd^2)	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Elongation: 20-Lb Load (Per Cent) Warp	Elongation: 20-Lb Load (Per Cent) Filling	Tear Resistance (Lbs) Warp	Tear Resistance (Lbs) Filling	Air Per-meability ($Ft^3/Ft^2/Min$)	Ref. Number
DTD 69A	Plain	---	100 x 100	1.4	40	40	--	---	--	---	None[a]	3, 25
Spun Silk	Plain	---	58 x 57	--	70	70	--	---	--	---	Increase[a]	3
DTD 69	---	---	---	--	--	--	--	---	--	---	a = 5.08[b] b = 0.592	5
--	Plain	---	130 x 104	1.52	35	52	--	---	4.0	5.3	---	21
--	Mock Leno	---	95 x 92	1.67	60	57	6.0	8.0	--	---	---	21
--	Mock Leno	---	94 x 93	1.66	58	53	6.2	7.4	--	---	---	21
--	Plain	---	127 x 84	1.38	40	51	8.3	7.7	3.0	8.0	---	21
--	Mock Leno	---	---	1.75	49	61	4.0	7.7	7.9	11.3	---	21
--	Mock Leno	---	---	1.79	49	49	5.0	9.7	4.9	7.0	---	21
--	Mock Leno	---	---	1.77	49	61	4.7	7.7	6.6	9.0	---	21
--	Plain	---	111 x 87	--	38	71	9.4	6.6	--	---	---	21
--	Plain	---	103 x 112	1.91	58	67	11.3	9.7	6.6	6.5	---	21
--	Mock Leno	---	104 x 112	1.92	53	67	13.0	8.7	7.1	8.8	---	21
--	Mock Leno	---	96 x 105	1.74	54	56	6.0	5.0	11.5	12.7	---	21

(Continued)

TABLE XXV (Continued)

SILK FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Weave	Yarn Size (Denier)	Construction	Weight (oz/yd^2)	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Elongation: 20-Lb Load (Per Cent) Warp	Elongation: 20-Lb Load (Per Cent) Filling	Tear Resistance (Lbs) Warp	Tear Resistance (Lbs) Filling	Air Permeability ($Ft^3/Ft^2/Min$)	Ref. Number
--	Mock Leno	---	---	1.30	45	28	6.0	10.0	12.9	5.7	---	21
--	Plain	---	---	1.87	32	65	8.0	6.0	--	9.5	---	21
--	Plain	---	---	1.53	46	41	7.0	5.0	--	---	---	21
--	Plain	---	75 x 97	1.58	42	54	4.3	7.7	--	---	---	21
--	Cross-Barred	---	---	1.64	25	41	15.9	4.3	3.4	9.6	78.1[c]	21
--	Mock Leno	---	---	1.99	45	69	8.0	7.0	10.2	13.2	125.4[c]	21
--	Plain	---	---	1.86	43	68	11.0	8.0	4.4	7.5	69.2[c]	21
--	Warp Knit	---	---	1.85	55	39	38.0	94.0	--	---	---	21
--	Plain	---	---	1.82	43	56	10.0	9.0	4.8	7.3	57.9[c]	21
--	Warp Knit	---	---	1.67	43	32	47.0	88.0	7.6	12.0	383.5[c]	21
--	Serge	---	---	1.92	40	48	9.0	9.0	7.2	10.2	88.3[c]	21
--	Warp Knit	---	---	1.86	52	41	51.0	91.0	10.7	7.8	---	21
--	Serge	---	---	1.73	42	52	8.0	7.0	7.4	7.9	68.2[c]	21
--	Plain	---	---	1.5	44	45	9.0	6.0	--	---	34.3[c]	21

(Continued)

TABLE XXV (Continued)

SILK FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Weave	Yarn Size (Denier)	Con-struction	Weight (oz/yd^2)	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Elongation: 20-Lb Load (Per Cent) Warp	Elongation: 20-Lb Load (Per Cent) Filling	Tear Resistance (Lbs) Warp	Tear Resistance (Lbs) Filling	Air Per-meability (Ft^3/Ft^2/Min)	Ref. Number
--	Mock Leno	---	---	1.84	45	58	8.0	8.0	10.6	11.1	---	21
--	Plain	15.1/12.6	139 x 92	1.30	42	29	6.7	7.3	--	---	27.3[c]	21
--	Plain	16.0/14.0	141 x 86	1.30	25	33	18.0	9.0	--	---	45.5[c]	21
--	Plain	29.2/14.8	97 x 77	2.67	99	72	10.4	7.9	--	---	27.9[c]	21
--	Plain	28.3/11.7	95 x 70	2.53	109	65	9.1	11.5	--	---	25.6[c]	21
--	Plain	14.7/14.4	94 x 78	2.73	101	76	12.3	9.4	--	---	29.4[c]	21
--	Plain	29.0/13.4	93 x 74	2.71	88	62	13.3	9.9	--	---	28.5[c]	21
--	Plain	13.9/13.8	76 x 86	2.09	57	63	5.4	8.6	--	---	19.1[c]	21
--	Plain	14.1/14.9	75 x 99	1.64	44	38	3.2	9.2	--	---	28.9[c]	21
--	Plain	13.6/13.2	77 x 94	1.79	52	52	5.4	8.6	--	---	24.2[c]	21
--	Plain	12.0/10.8	96 x 78	2.58	88	70	8.0	9.4	6.0	4.9	27.7[c]	21
--	Plain	11.7/11.8	75 x 102	1.63	57	57	3.4	11.4	4.3	3.2	57.7[c]	21
--	Plain	12.6/13.7	75 x 101	1.53	43	31	3.4	8.7	3.8	2.1	24.2[c]	21
Japanese Habituai	Plain	14.9/24.5	134 x 94	1.45	39	67	11.4	5.4	1.8	4.3	62.9[c]	21

(Continued)

TABLE XXV (Continued)

SILK FABRIC DATA

PHYSICAL AND TEXTILE PROPERTIES

Fabric Number	Weave	Yarn Size (Denier)	Con-struction	Weight (oz/yd²)	Tensile Strength (Lbs/In) Warp	Tensile Strength (Lbs/In) Filling	Elongation: 20-Lb Load (Per Cent) Warp	Elongation: 20-Lb Load (Per Cent) Filling	Tear Resistance (Lbs) Warp	Tear Resistance (Lbs) Filling	Air Per-meability (Ft^3/Ft^2/Min)	Ref. Number
--	Plain	---	115 x 106	1.76	31	64	8.7	8.3	--	---	36.6[c]	21
--	2/1 Twill	---	---	1.6	40	40	--	---	4.0	4.0	80-140[d]	7
Navy No. 2759	Plain	---	---	1.55	45	45	--	---	3	4	---	2
Army No. 16066	---	---	---	1.5	40	40	--	---	4	4	80-140[d]	2
--	---	---	120 x 119	1.49	52.5	57	--	---	--	---	0.169[e]	28
--	---	---	121 x 115	1.38	47.3	38.1	--	---	--	---	0.160[e]	28
--	---	---	126 x 93	1.53	53.5	53.8	--	---	--	---	0.229[e]	28
--	---	---	125 x 94	1.55	45.6	41.2	--	---	--	---	0.237[e]	28
--	---	---	---	1.57	54	44.9	--	---	--	---	0.169[e]	28

[a] Effect of increasing tension on air permeability.

[b] Data fit an empirical curve of the form $Y = aX^b$, measured at a pressure range of 1/2-17 inches of water.

[c] Pressure difference = 1 lb/ft^2.

[d] Measured at 1/2 inch of water.

[e] Resistance to airflow (drop in pressure across fabric, lbs/in^2).